Official Proceedings

OF THE

Western Railway Club

FOR THE

Club Year 1899-1900

The Club meets the third Tuesday of each month, except June, July and August.
The Club Year ends with the meeting in May.

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WESTERN RAILWAY CLUB

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular monthly meeting of the Western Railway Club was called to order at 2 p. m., Tuesday, September 19, 1899, in the Auditorium Hotel, Chicago. President H. G. Hetzler in the chair.

Following are the names of those who registered:

Amory, E. P.
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Jennings, D. J.
Johann, Jacob.
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Kirby, T. B.
Lester, F. A.
Manchester, A. E.
Mason, G. G.
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Medway, John.
Mileham, C. M.
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Pattee, J. O.
Peck, P. H.
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Koberts, C. A.
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Sanborn, T. G.
Sargent, F. W.
Sawyer, E. C.
Scales, R. P.
Schroyer. C. A.
Scott, G. W.
Shea, R. T.
Showers, G. W.
Smart, R. A.
Slater, F.
Smith, F. H.
Smith, R. D.
Taylor, J. W.
Tratman, E. E. R.
Whitridge, J. C.
Whyte, F. M.
Wickhorst, M. H.
Woods, J. L.

The President: The first business of the meeting is the approval of the minutes of the May meeting, which were published in the Proceedings, and if there are no objections they will stand approved as printed. The minutes are approved.

The Secretary will please read the list of new members which have been approved by the Executive Board.

The Secretary then read the following names:

J. C. Batchelder, Supt. B. & O. R. R., Garrett, Ind.

R. W. Bayley, Western Representative, Westinghouse Air Brake Co., 774 Rookery Building, Chicago, Ill.

I. H. Brown, Westinghouse Air Brake Co., Pittsburg, Pa.

W. B. Galivan, 190 South ave., Chillicothe, Ohio.

G. R. Henderson, Asst. Supt., M., P. C. & N.-W. Ry., Chicago, Ill.

A. C. Hone, Supt., M., P. E. & T. H. Ry. Co., Evansville, Ind.

F. L. Johnson, Chicago, Burlington & Quincy R. R., Chicago, Ill.

C. M. Marshall, 212 22nd street, Mattoon, Ill.

A. R. McAlpine, Burton Stock Car Co., Chicago, Ill.

W. F. Milligan, 920 Sixth street, Sioux City, Iowa.
T. S. Reilly, 1305 Manhattan Building, Chicago, Ill.
Irwin Stetler, 1346 Park avenue, Chicago, Ill.
Jos. W. Taylor, 667 Rookery Building, Chicago, Ill.
Otis Weeks, Roadmaster, Northern Pacific Ry., Junction City, Kan.

The President: The next business is the report of the Auditing Committee as reported to the Executive Board, which the Secretary will please read.

The Secretary then read the following report:

Chicago, August 1, 1899.

To the President, Western Railway Club, Chicago, Ill.

Dear Sir: The undersigned, your committee appointed to audit the accounts of the Secretary and Treasurer of the Western Railway Club for the past year, do hereby report that it has gone over the accounts from May 17, 1898, to July 13, 1899, and find them to be correct. Respectfully submitted,

F. W. Sargent,
R. D. Smith,
Committee.

The President: The Secretary will please announce the progress of the Committee on Specifications.

The Secretary: This report has been promised for some time; it was ready to present verbally at the May meeting, but it was thought desirable by the directors to present it in the form of a written report, so that it could go out as an advance paper, and so, perhaps, receive more attention at the club meeting. This report will be the paper for the October meeting.

The President: At the Executive Board this morning the question of holding a banquet was brought up and discussed, and I will ask the Secretary to report the decision of the Executive Board.

The Secretary: The board took the position that it was not desirable to have a banquet this year. The banquet was omitted last year, and, the directors thought, with good results. They take this position: there are about nine hundred members, and about two hundred of these attend the banquet. The expense on the part of the Club is about $150 to $200, and six hundred members at least would get no benefit from this expenditure. They think it is best to continue the binding of the Proceedings as was done last year and until the end of the year, when they can feel secure that there will be sufficient funds to insure this. It is thought best not to consider a banquet. They also would like to continue to furnish the proceed-

ings of the other clubs to those of our members who are entitled to them and require them, and this will be a considerable expense this year. These are the two principal reasons why they want to cut off all other expenses, and they recommend that this action be endorsed by the Club.

The President: I do not think Mr. Whyte brought out clearly the intention of the Executive Board. It was the intention to convey to the Club the expression of the Executive Board that it was advisable not to hold the banquet, but if the Club, as a body, prefer to have a banquet, it can do so. It is in order now to bring this question up. A motion is in order.

Mr. P. H. Peck: I think, Mr. President, that we should not consider a banquet this year. I agree with the Executive Committee that the bound Proceedings are of more value to every member of the Club than the banquet is to a few. I make the motion that we dispense with the banquet this year.

The foregoing motion was seconded and carried.

The President: I think it would be well to bring out at this point, the fact that there are quite a number of our members who have not paid their dues, and I will say for the benefit of all, that those who have paid their dues for the present year will receive the Proceedings of the Western Railway Club, and those who are owing for this year, and last year, will not receive the Proceedings, and those who are back on their dues for three years will be dropped from the membership roll, they not being members until the back dues are paid up.

I would like to state further, that when the bills for the present year's dues were sent out to the different members, it was explained then that those who had paid the dues for the present year, would be entitled to the Proceedings of the New England, Central, Northwestern and possibly the New York clubs, if they have communicated the desire for them to the Secretary, as long as it is possible for the Club to do so. Mr. Whyte will explain why this condition has been made necessary.

The Secretary: At the meeting of the Railway Clubs' Secretaries, last June, their report showed that the following action was taken:

"The New England R. R. Club, through its Secretary, E. L.

Janes, gave notice that in future that club will not exchange proceedings with other clubs except on a cash basis."

Most of the other clubs have taken the position that those of their members who want the proceedings of other clubs shall be charged extra for the proceedings, and generally on the basis of $1.00 for the proceedings of each club desired. The Western Railway Club has not found it necessary yet to require this extra amount and, as a result, the members of this Club who are members also of other clubs charging the extra fee, are getting the proceedings of the other clubs through this Club, and this throws a very heavy expense on our Club. It is this heavy expense which will fall on the Western Railway Club, and the amount of which the directors cannot foresee, which made necessary the warning given in the notice mailed to each member, to the effect that the proceedings of other clubs might or might not be furnished for the whole year.

The President: The next business is new business. If there is no new business to come up, I will take this opportunity to announce, as most of you are already aware, that Mr. Whyte, our present Secretary, has accepted a position on the New York Central, making it impossible for him to continue to act as our Secretary, and at a meeting of the Executive Board, held September 12, Mr. J. W. Taylor was unanimously elected Secretary to succeed Mr. Whyte.

Mr. F. W. Sargent: In view of the fact that under the Secretaryship of Mr. F. M. Whyte the Western Railway Club has prospered, the attendance has increased, the finances have been brought to a fine state of efficiency, it seems proper that we should extend to Mr. Whyte the regrets of the Club at his having to give up the Secretaryship and that we should vote him a resolution of thanks for the very efficient service he has rendered during his term of office. I move that the thanks of the Club be extended to Mr. F. M. Whyte. (Seconded.)

The President: You have heard the motion made by Mr. Sargent and seconded; all those who are in favor of this motion, please manifest it by saying, aye.

The motion was put to vote and unanimously carried.

Mr. Whyte: Gentlemen, I thank you.

The President: I feel that each member is justly proud of the Western Railway Club, and the rank it has taken among other simi-

lar clubs, and desires that it will continue to progress as it has done during the previous years.

Our success does not depend wholly upon the work of the officers of the Club but, to a great extent, upon each member, and I wish to take this opportunity to invite every member to take an active part in our meetings, also to ask all members who may have subjects or papers which will be of interest to the Club, to communicate with the Secretary.

I believe the next business is the paper of today—a very interesting and valuable paper written by Mr. J. Snowden Bell.

The Secretary then read the following paper :

Locomotive Front Ends

By J. Snowden Bell

The importance of correct design and proportions of the front end of a locomotive boiler, in promoting the effective and economical performance of the engine, while not entirely overlooked by the earlier constructors, has not, until a comparatively recent date, been given the recognition which it demands, nor induced the experimental research by which the principles involved may be so applied in practice as to insure the attainment of the best results under the conditions of service presented in standard American locomotives. The term "front end" is ordinarily understood to comprehend the smoke box and stack, and their accessories and contained members, the essentials of which latter are the steam and exhaust pipes, a draught appliance, and some means for preventing, or attempting to prevent, the discharge of sparks or ignited fuel from the stack. A detailed consideration of these different members would be much beyond the permissible compass of the present paper, which will be limited to a review of the more important features of the front end, as a whole, and an indication of the general lines of present practice.

The front ends of the early locomotives built in the United States, were substantially similar to those of the English engines which preceded them. The smoke box was of D shape in cross section, and had a straight open stack. The steam and exhaust pipes were carried to and from the cylinders, inside the smoke box, as in present practice, and the exhaust nozzles were usually double and high. The cylinders were attached to the bottom of the smoke box, if a crank axle was used, or to the sides, in outside connected engines. No special draft appliance or spark arrester was used. Fig. 1, which is reproduced from Plate 2 of "Pambour's Practical Treatise on Locomotive Engines," American Edition, 1836, illustrates all the essential features of the earliest type of front ends. Apparently as a matter of mere mechanical convenience, and without any rule or basis as to its volume or capacity, the smoke box was made about the same length as the cylinders, and this continued to be the universal practice until the advent of the lengthened or extended smoke box, or so-called "extension front," in 1859.

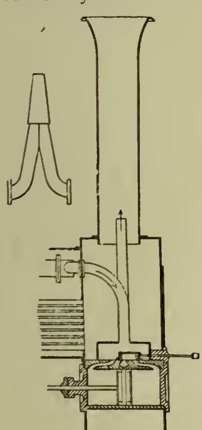

Fig. 1.

The contracted exhaust nozzle, as a means for effecting the forced draft which is essential in a locomotive boiler, was doubtless recognized at the outset,

as it has been ever since, as a necessary evil—one that could not be avoided, but might, as subsequent practice has shown, in some degree, be lessened, and while its greater objection, the resultant back pressure on the pistons, could neither be removed nor reduced to any material extent, the lesser one, that of throwing ignited and partially burned fuel from the stack, very soon became the subject of efforts at prevention. Any and every spark arrester is necessarily an attempt to compromise two directly conflicting conditions—one being perfect freedom of draft, and discharge of smoke and gases, and the other the prevention of the escape of solid matter in a state of ignition from the stack. It naturally results, from the impossibility of reconciling these conditions, and the imperfect compliance with each of them which it is possible to make, that none of the long array of spark arrester designs which have been proposed, or even of the comparatively small proportion of them which has been put into practice, has been entirely successful or satisfactory, and practically only two types—the diamond stack, and the open stack with spark arresting appliances in the smoke box—have survived the test of actual service, and are now in use to any substantial extent, on the railroads of the United States.

Spark arrester history, in addition to being extremely lengthy, is mainly the recital of a succession of failures, and it would not here be either interesting or profitable to do more than note its initial steps and its present status. The first spark arrester was doubtless a cap of wire netting connected to a widened top section of an otherwise entirely open stack, such as is shown in familiar illustrations of the early Baldwin and Norris engines. The next step was the addition of a cone or deflector below the netting, thus giving the elements of the present diamond stack. The earliest authentic record of a spark arrester of any kind is believed to be the U. S. patent of J. P. Espy, June 29, 1833, a copy of which is published in the Journal of the Franklin Institute, Vol. XII, New Series, 1833, page 418, together with certificates of the satisfactory performance of the appliance on "Mr. Baldwin's locomotive engine" on the Philadelphia & Germantown railroad, and on a steamboat. Espy's device, which he termed "a draft generating chimney cap," consisted of a horizontal conical cap, with a lower neck fitting around and turning on the upper end of the stack, and having a vane on its top, "to turn the angle of the cap always to the wind." The open end of the cap was about "thirteen or fourteen times the area of the top of the chimney," and was covered with "wire gauze so fine that a pin's head can hardly be thrust through the meshes." Notwithstanding the remarkable results alleged to have been produced, among which was an absolute *increase* of draft and an economy of *one-third* in fuel, no record appears of the continued use of this device.

It is of interest to note, in this connection, that the volume of the Franklin Institute Journal above referred to, contains the earliest instance which has been found, of a spark arresting appliance in the smoke box, being a communication, on pages 74-77, from J. McIlvaine, describing and illustrating his "Arrangement for stopping sparks from the flues of locomotive engines in which wood is used as fuel." This appliance was a sheet of wire netting, extending in an inclined position entirely across the smoke box, from the top of the flue head to the bottom of the smoke box front, the exhaust pipe passing through it. This is the pioneer in

the line of perforated deflectors set in front of the tubes, and its principle is embodied, to a large extent, in present practice.

The report of the committee on "Locomotive Boilers" of the American Master Mechanics' Association, published in their Proceedings for 1884, pages 27-44, shows, in Plate No. 28 A, a spark arrester containing a conical deflector, exterior netting, and a casing for sparks surrounding the stack, the construction being generally the same as that which is known as the "bonnet" or "balloon" stack, and which was for many years used almost universally on wood burning locomotives, and also to a large extent with bituminous coal. This spark arrester is stated to have been designed, built, and used in June, 1833, by Isaac Dripps, on the Camden & Amboy railroad. Whether this statement is entirely accurate or not, there is little doubt that the conical deflector was devised at an early day, and but little, if any, later than the time stated.

Appliances for regulating or approximately equalizing the draft through the upper and lower rows of tubes were the next addition which was made to the

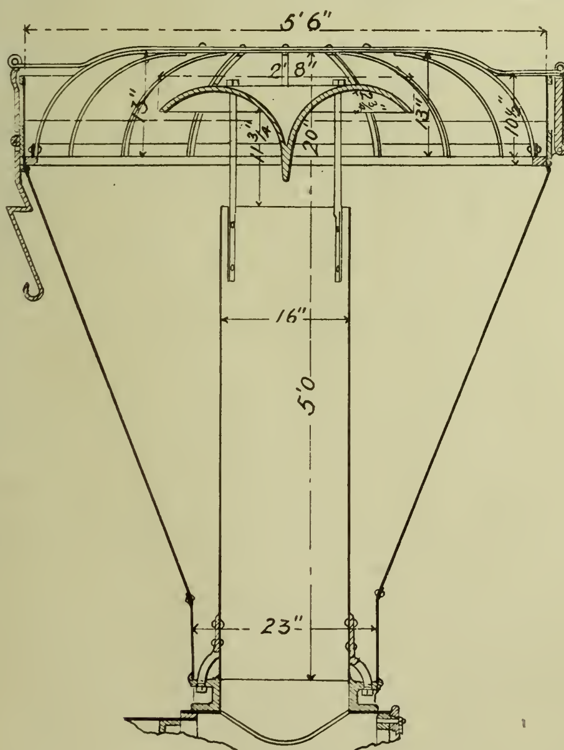

Fig. 2.

smoke box, and it is a somewhat remarkable fact that only two of them, and these the earliest that were developed, have continued to be used sufficiently to be worthy

of mention, and are to-day elements of general and approved practice. These are the "petticoat" or lift pipe, and the deflecting plate in front of the flue sheet. There does not appear to be any authentic record of the origin of the petticoat pipe, but it was undoubtedly introduced at a very early date, and probably by some New England locomotive builder. Mr. L. B. Paxson, of the Philadelphia & Reading railway, states that those which he found in his early experience on that road were made in separate sections, one above the other, and this feature has been adopted in the present standard construction. According to the report in the 1884 Master Mechanics' Association Proceedings before referred to (see Plate No. 28 E), the deflecting plate was designed by Isaac Dripps, in 1849, and an illustration is given showing an inclined perforated deflecting plate, practically the same as some of comparatively recent date. It was not, however, adopted outside the Camden & Amboy railroad, or practically known of by railroad men, until some time in the sixties, after which, however, some form of deflecting plate became an essential feature of spark arresters which were located in the smoke box. The standard and almost universal practice in front ends in 1859, and in the large majority of instances, for twenty years or more thereafter, comprised a bonnet stack of large diameter, a petticoat or lift pipe, and low exhaust nozzles, these elements being previously noted. Fig. 2 shows the form of bonnet stack made by William Mason, of Taunton, Mass., which was among the largest, being sixty-six inches in diameter at its top. This design of front end, modified by the substitution of a "diamond" stack, which will be referred to more fully hereafter, for the bonnet stack, remains as one of the two ruling and distinctive types of present practice. The other, the extended smoke box, will now be considered.

Prior to the year 1859, it had been the universal practice to make the length of the smoke box about the same as that of the cylinders, this being done mainly, if not entirely, for structural reasons, although it had also been, before that time, maintained by writers of admittedly high standing as authorities, that a reduction of smoke box volume was not only correct in principle but also advantageous in practice. A radical innovation was made in 1859, by adding to the smoke box a forward extension or "extension front," the length of which was first proposed as about eighteen inches, but which was afterwards made very much greater, the average length being, until comparatively recently, thirty-six inches, and in some cases forty-four inches or more. The volume of the smoke box was thus increased considerably over 100 per cent. The invention of the extended smoke box was claimed by John Thompson, of East Boston, Mass, who was, at the time, master mechanic of the Eastern railroad, and it was patented by him in the United States, May 29, 1860, No. 28,520. Mr. Thompson's theory of the operation of the extended smoke stack is stated by him in the specification of his patent as follows:

"The nature of my invention consists in extending the smoke arch or smoke box, in manner hereinafter described, so far beyond the chimney and the blast pipe that the sparks and cinders ejected from the stack of pipes connecting the smoke arch with the furnace may be thrown so far forward beyond the draft or current of smoke passing from the stack [the tubes] to the chimney, as to fall down and settle or be retained within the smoke box. . . . I have found that by extending the smoke box some considerable distance, that is, about eighteen inches or more, in manner as described and represented, beyond the course of the draft, most, if not all of the sparks and cinders, will pass beyond the current of smoke and be deposited in the smoke box."

He also says that his invention "has been thoroughly tested on seven locomotives, and found to be of great practical utility and advantage," and makes the following claim :

' The improved smoke box as so extended beyond the smoke current leading from the pipe stack to the chimney, that the sparks or cinders discharged through the pipe stack may pass out of and beyond the current of smoke, so as to be deposited in the box by the action of gravity, and not be carried up the chimney."

As will be seen from Fig. 3, which is reproduced from the drawing of the Thompson patent, the theory of the patentee that the sparks and cinders would be deposited and retained in the smoke box extension, was relied upon to constitute it

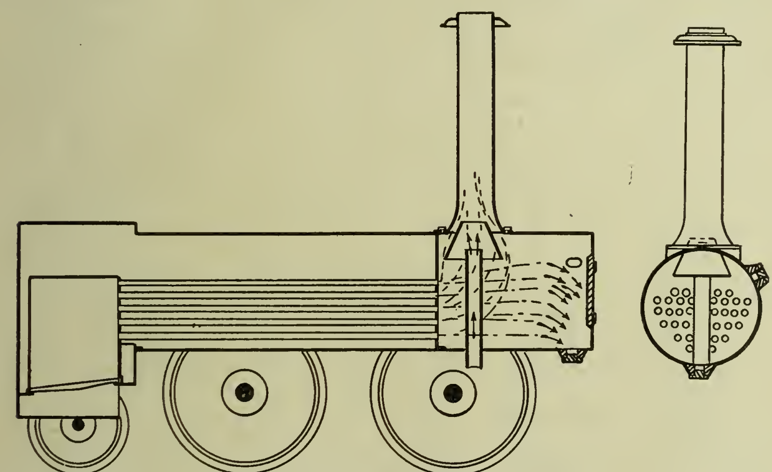

Fig. 3.

a *spark arrester*, and no netting or other spark arresting appliance was proposed. It is hardly necessary to say that this theory was speedily shown to be entirely unfounded, and additional devices for arresting sparks were found to be indispensable. Commencing with a horizontal sheet of netting, extending from the flue head to the smoke box front, above the top rows of tubes, which was the first expedient adopted, or one of the earliest, various designs of netting and deflecting plates were, in the course of time, designed and applied by those who continued to use the extended smoke box. It is obvious that, in and of itself, this appliance can possess no merit as a *spark arrester*, and its capabilities as a spark receptacle or *retainer* are so limited that they are no longer urged as an argument in its favor, it being now generally recognized that practically all the solid matter that passes through the tubes is thrown out of the stack, and that if this can be done without liability to start fires on or adjacent to the right of way, it is desirable that the smoke box should be cleared by the exhaust.

In "Locomotives and Locomotive Building," published by the Rogers Locomotive & Machine Works, of Paterson, N. J., in 1886, an illustration and description is given on pages 40 and 41, of an extended smoke box and deflecting plate, used with a "bonnet" stack. The description states that "As early as 1859

"some engines were built at the Rogers Works for the New Jersey Railroad & Transportation Company, with a form of extended smoke box, shown in Figs. 93 and 94. A deflecting Plate A was used in front of the top rows of tubes."

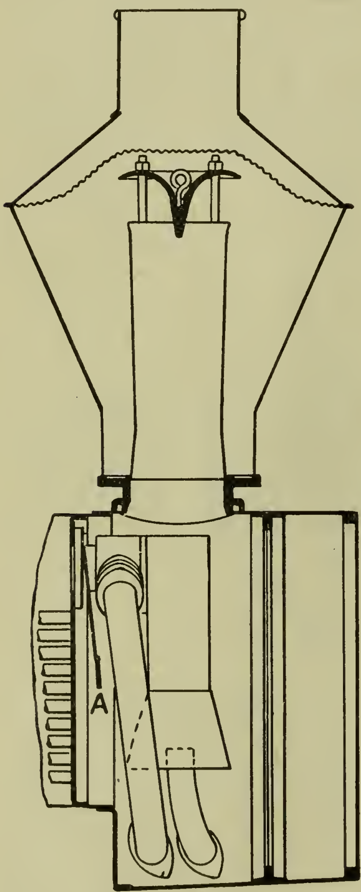

FIG. 4.

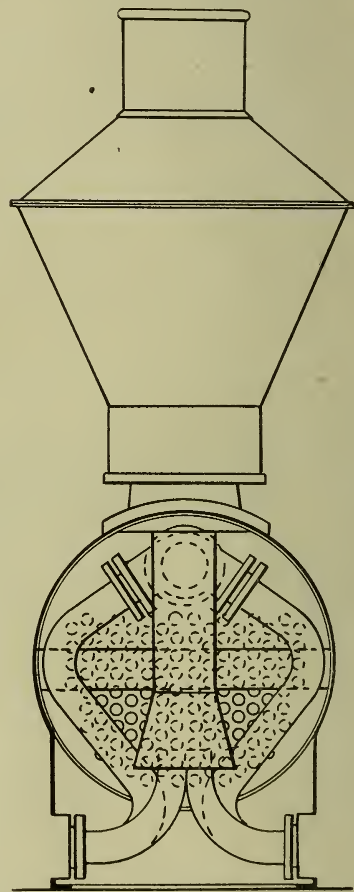

FIG. 5.

The illustrations referred to are reproduced as Figs. 4 and 5. While the broad and impracticable idea of a smoke box extension, without any spark arresting appliances, may have been original with Thompson, it would thus appear that its first embodiment in such form as to be adaptable to practical service with any degree of success, was made by the Rogers Locomotive Works.

An approximately complete and correct statement of the development of spark arresters in the United States, with illustrations of many patented designs, will be found in the report of the committee on "Spark Arresters" of the American Master Mechanics' Association, which is published in their Proceedings for 1883, pp.

89-197. This report will repay perusal by those sufficiently interested, but is of little practical value otherwise than in indicating a category of vagaries which it is extremely desirable to avoid.

Disregarding the numerous special designs of spark arresters, which had been previously, and were thereafter produced, the large majority of which was of the "freak" order, and made no record of substantial interest or value in practical service, the ruling practice in locomotive front ends in 1860 was a short smoke box, or one about the length of the cylinders, a "bonnet" stack for wood and bituminous coal burning engines, and a straight open stack (sometimes provided with a grating on its top to arrest sparks) for anthracite coal, low exhaust nozzles (usually double), and a petticoat pipe. Very few applications of the extended smoke box were made prior to 1880, when it was adopted by the Pennsylvania railroad, after which it rapidly gained in favor, and, until a few years past, was practically standard on the railroads of the United States. The transition from the practice of 1860, as above outlined, to that of the most recent constructions, and the leading features as to which a general agreement appears in present practice, may be considered with advantage in connection with the action taken, and views presented, from time to time, by committees of the American Master Mechanics' Association, a synopsis of which will be both interesting and profitable, and will not, it is hoped, be found to be tedious or unduly lengthy.

At the second annual convention of the association in 1869, a report was made by the committee on "Smoke Stacks, Ash Pans, and the general subject of Draft." The conclusions of the committee are of interest, as indicating the sense of the association, at that date, as to front ends, and are stated by them as follows (Report 1869, pp. 34, 35):

"The best form of stack for wood burning engines is the 'bonnet' stack, having a diameter at the top of from five to five and one-half feet, as generally used on wood burners. This form of stack gives a better draft (other things being equal) than any known to your committee. There are other stacks that more effectually prevent the emission of live sparks, but it is accomplished at the expense of the draft. A large diameter at the height of the cone, and a large area of wire netting is necessary to insure good draft, and prevent sparks being ejected in objectionable quantities.

"The inside pipe of the stack should be as high as practicable—from four to four and one-half diameters, and the bottom where it joins the smoke box should be bell-mouthed for five or six inches up. For the next eighteen inches the pipe should be straight, and, as a rule, about one inch smaller than the diameter of the cylinders; from that to the top the pipe should enlarge at the rate of one inch to the foot; the inside of the pipe to be as smooth as possible. This form of pipe will, in the opinion of your committee, offer the least resistance to the ascending column of steam and the products of combustion, and produce a better draft than any other.

The petticoat pipe, generally used in the smoke box, should be about two-thirds the diameter of the inside pipe of the stack, with a flange at the bottom. The top should be three inches below the top of the smoke box, and the bottom of the same height as the top of the exhaust nozzles. We consider it immaterial whether the pipe be in sections or in one piece.

"The smoke box should be of a capacity equal to the diameter of the boiler. and a length from flue sheet to front equal to about one and one-fourth times the length of the stroke.

"We recommend the double exhaust nozzle in preference to the single, as giving the best results, all things considered. The advantages of a single nozzle do not sufficiently compensate for the back pressure produced in the opposite cylinder at the moment of, or during the continuance of the exhaust. The top of the nozzle should be as high as the third or fourth row of tubes from the bottom. Their shape on the inside should be straight for ⅜ of an inch from the top, and when within 2½ inches of the top widen out to the full size of the exhaust pipe. The nozzles should be as close together as possible, and so *directed* that the exhaust steam will strike the center of the cone at top of the stack. Variable exhaust nozzles have invariably given trouble on account of "gumming up," and soon become worthless as *variable* exhausts.

"Smoke stacks for engines burning soft coal require a different construction at the top from those burning wood. So great an area around the cone, and of wire netting, is not required. A stack that will clean itself well, that is, permit no lodgment of sparks or cinders in it, or in the smoke box, and at the same time throw no fire or large cinders, and having a good draft, will answer well for burning soft coal. The particular form of the top is not very material, yet that known as the diamond shape top, or something approaching it, with an annular space between the outer edge of the cone and the wire netting of from three to six inches, thereby avoiding gumming of netting, we believe to be the best arrangement of stack for burning soft coal. The remarks in regard to the form of the inside, petticoat and exhaust pipes, proportion of smoke boxes, etc., for wood burning engines, apply equally to coal burners.

"For engines burning anthracite coal, the plain open stack without cone or netting is recommended."

The same committee reported at the next annual convention (1870), and recommended no change, so far as relating to front ends.

At the sixth annual convention of the association in 1873, in the course of a discussion on the comparative values of anthracite and bituminous coal and wood as fuel, the opinion was expressed by one of the members that "The smoke box acts upon the fire as an air vessel upon a pump—the larger it is within a reasonable limit, the more benefit you will get of your fuel." Another member said that, "There is no doubt that the smoke box acts as a sort of air chamber, and that the suction derived from the flues is more uniform when the box is large and the exhaust does not jerk the fire." This appears to be the earliest mention of the ingenious "air chamber" theory which has lately been revived as an argument in support of the extended smoke box, but which, unless the words "within a reasonable limit" be taken in a very limited sense, has been fully demonstrated to be an incorrect one.

The committee on "Construction of Locomotive Boilers," at the ninth annual convention in 1876, stated that "The only information received in reply to our query for a perfect spark arrester is embodied in replies from Mr. Coolidge, of the Fitchburg railroad, and Mr. Hill of the Camden & Atlantic railroad." Mr. Coolidge used the Hawkes & Paine diamond stack, with a pipe for returning the

sparks to the fire box, and Mr. Hill an extended smoke box, and a pipe and steam jet for returning sparks to the fire box. Notwithstanding the theoretical advantage of this disposition of the sparks and cinders, the possibility of its practical utilization, and the satisfactory results which were alleged to have been obtained on the two roads referred to by the committee, and on some others on which appliances on this principle were in service, the system appears to have been soon and finally abandoned. It is doubtless unnecessary to add that the "perfect spark arrester" which the committee, in common with most, if not all, of their brother master mechanics were in search of, has not, up to this date, been discovered.

Nothing further of interest in relation to the subject of front ends is to be found in the reports of the association up to that of the sixteenth annual conventian in 1883, at which the committee on "Spark Arresters" presented the lengthy illustrated report, which has been previously noted. A report was also presented at this meeting by a member representing or constituting the committee on "Extended smoke boxes," from the caption of which much valuable information might reasonably be expected, it being entitled, "Is the extension of the smoke box in locomotive engines beneficial? If so, to what extent?" (Proceedings, pages 180-185.) This report is, however, extremely indefinite and wholly inconclusive, and, as in later discussions of the same subject, treats the brick arch in firebox as being, in some unexplained manner, related to the extended smoke box. The claims of the author of the report as to a 20 per cent saving in fuel, enlargement of exhaust nozzles, more uniform draft, and freedom from fires on line of road, by the use of the extended smoke box *and brick arch*, are unsupported by data of comparative tests, and are manifestly not in accord with the results of the continued use of the extension and the experience of master mechanics in general. There can be no doubt that the report is designed to convey the impression that the extended smoke box (and brick arch) *are* beneficial, and very much so, but *how* much, the author of the report prudently refrains from stating, neither does he give any particulars as to the construction with which these appliances were compared, other than that it was "the old diamond stack and lift pipe." If his conclusions were correct, under the conditions of the comparison which he made, the construction which he condemns must have been very *old*, and correspondingly defective in all particulars.

The extended smoke box had, by this time, been adopted by locomotive builders generally, in deference to what, in the light of subsequent developments and changes in practice, may not unreasonably be termed a popular *craze*, and up to 1894, when a change of sentiment was first decidedly manifested, the tenor of the references to it in the reports of the association is uniformly commendatory. Thus, the committee on "Smoke Stacks and Spark Arresters," at the eighteenth annual convention in 1885, states among its conclusions (Proceedings, page 155), the following:

"2. An extension front end, when properly constructed, makes a very satisfactory spark arrester, and as a consequence is less injurious to the paint on cars and adds greatly to the comfort of passengers, and is to be recommended on that account. It also has some merits as an economizer of fuel, but not to any great extent."

The report of the committee on "Extension Smoke Boxes" at the twentieth annual convention, 1887, was also favorable to the extension, although no sub-

stantial reasons or results of tests were given, and one enthusiastic member desired it to be adopted that "It is the sense of this meeting that an extension front is the proper construction for a locomotive, and an improvement thereon." This suggestion was not, however, adopted.

A report was made at the twenty-first annual convention, 1888, by the committee on "Extension Fronts and Brick and other Firebox Arches," which was generally in favor of the extension, and it was given the following qualified endorsement (Proceedings, page 56):

"As spark arresters, and consequent safeguards against fire, cleanliness to trains and economy of maintenance, when properly constructed and within certain proportions, the extension fronts and open stacks are decided improvements in locomotives designed to burn the average quality of bituminous coal."

The subject was discussed at the twenty-second and twenty-third annual conventions, 1889 and 1890, the extension being, as usual, considered in connection with the brick arch in firebox, and credited with whatever advantages were found in the latter.

The report of the committee on "Exhaust Pipes, Nozzles, and Steam Passages," at the twenty-fourth annual convention, 1891, was mainly devoted to exhaust pipes, but also contains the following expression of its views as to the taper or "choke" stack (Proceedings, page 40):

"The committee has had considerable experience with both straight and taper form, and it is of the opinion that the stack with double taper is decidedly the best, and owing to its shape, will not be subject to the same wear as the straight pattern, which, as we all know, is generally cut through, near the upper part. Taper stacks made in the spring of 1885 are still in service."

The report of the committee on "Exhaust Nozzles and Steam Passages," at the twenty-seventh annual convention, 1894, together with the ensuing discussion (Proceedings, pp. 108–132) is of exceptional interest and value in connection with the correct and true mechanical design and proportions of locomotive front ends and their related appliances. The conclusions of the report are based, not upon superficial observation or concurrence with previous practice, which, in many cases, was largely, if not altogether, force of habit, or the following of the lines of those who were supposed to be safe authorities and leaders, but upon practical tests, intelligently and thoroughly conducted, by members of a committee, the abilities of whom are beyond question, and who have shown themselves to be wholly devoid of prejudice or bias. The report is too lengthy to be here reproduced in its entirety, and is not susceptible of satisfactory abridgment, and it will suffice for present purposes to quote merely its sixth conclusion, which is as follows (Proceedings, page 112):

"6. This test shows that an increase of the length of the smoke box over and above that necessary to get in a cinder pocket in front of the cylinder saddle is unnecessary and undesirable, as the long smoke box greatly decreases the vacuum. Sufficient area of netting can be put into a smoke box which is long enough to give room for a cinder pocket in front of the cylinder saddle."

As was stated by the late D. L. Barnes, a member of the committee, in the discussion of the report (p. 122), "This report is quite against the long, and decidedly in favor of the short smoke box. Zerah Colburn, many years ago, found that a short smoke box gave very much more vacuum than a long one, and these

tests corroborate that conclusion." The correctness of the position taken by the committee, as to the extended smoke box, is so clear and unquestionable, that the report did not fail to speedily and favorably impress many motive power officers, and since its publication, the decline of the extension, while for obvious reasons not as rapid as its rise, has been decided and continuous, culminating, as has been recently evidenced, in its abandonment by the Pennsylvania railroad on their latest and most improved types of engines.

At the same convention of the association at which the report last referred to was made, there was also presented a demonstration, in facts and figures, of the inefficiency and undesirability of the extended smoke box, which is not only wholly at variance with the extravagant claims of advantage which, as we have seen, had previously been made for it, but also confirms, by results in service for a long period, and with a large number of engines, the correctness of the committee's sixth conclusion above quoted. This was given by Mr. J. H. McConnell, superintendent of motive power of the Union Pacific railroad in the course of the discussion on the committee's report, and is particularly persuasive and forcible, for the reason that it is absolutely devoid of argument, and is simply a clean-cut statement of facts, the correctness of which does not seem to have been then or thereafter disputed. The following excerpt from Mr. McConnell's remarks (Proceedings, page 124) is believed to be of sufficient interest to be quoted at length :

"The result of the diamond stack in dollars and cents to our company has been that in 1890 we hauled 254 loaded freight cars one mile with a ton of fuel; in 1893 we hauled 260 cars with a ton of fuel. In passenger service in 1890 we hauled 119 passenger cars with a ton of fuel, and in 1893 we hauled 145 passenger cars with a ton of fuel. In 1890 we hauled 2,590 tons of freight one mile with a ton of coal. In 1893 we hauled 2,757 tons of freight one mile with one ton of coal. In 1890 our engines were all equipped with extension front and straight stack. In 1893 they were all equipped with the diamond stack. In 1890 the cost of handling a loaded car, including all the expense of the motive power and car department, was 3.17 cents. In 1893 it was reduced to 2.79. Our train haul is increased. In 1890 the passenger service was five passenger cars to a train; in 1893 it was 5.96. Our freight service has increased. We were handling 15.86 cars in a train in 1890, and we were handling 17.12 cars per train in 1893. Our tonnage has increased, and we have saved in one year 87,000 tons of coal by using the diamond stack over the extension front end."

Whether or not the diamond stack front end used by Mr. McConnell is the best and most desirable construction, under any and all conditions of fuel and service, is a question wholly separate and apart from that of the relative merits of that construction and of the extended smoke box, and one which is much too far-reaching for discussion here. It seems, however, conclusive that Mr. McConnell was correct in his further statement that "for the Union Pacific road it is more economical to use the diamond stack, and we get better results from the diamond stack than we did from the extension front end."

The report of the committee on "Exhaust Nozzles and Steam Nozzles and Steam Passages" was briefly discussed, chiefly as to a continuance of the investigation, at the twenty-eighth annual convention, 1895, and while it is so clear and plain that its essential features are unmistakable, it may be noted that they were reiterated by Mr. D. L. Barnes, who said : "Our recommendation related solely to

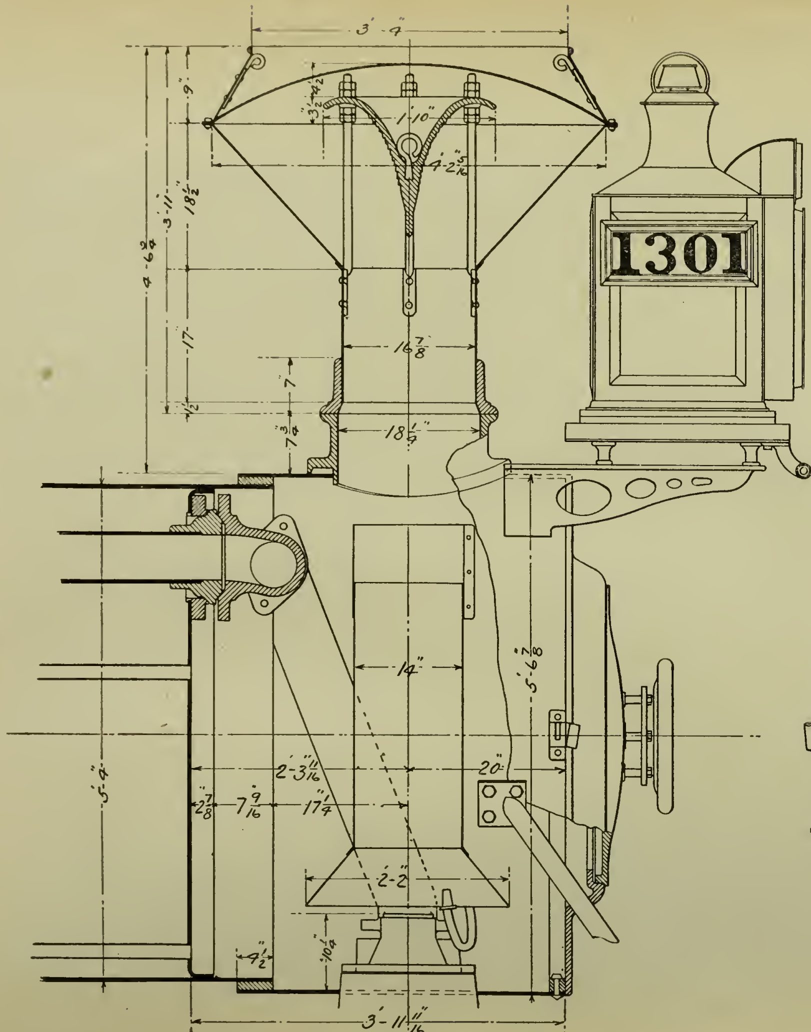
3' 4"
9"
3½"
4½"
1'-10"
4'-2 5/16"
4'-6¾"
3'-11"
18½"
17"
16 7/8"
7"
½"
7¾"
18¼"
1301
14"
5'-6 7/8"
5'-4"
2'-3 11/16"
20"
2 7/8"
7 9/16"
17¼"
2'-2"
10¼"
4½"
3'-11 11/16"

Fig. 6.

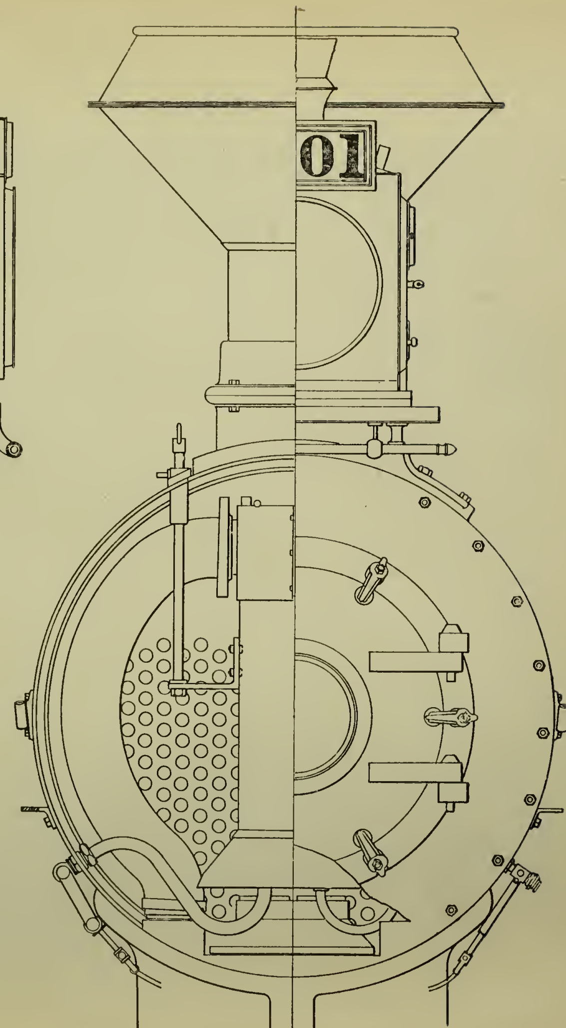
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Fig. 7.

having a low nozzle and tapered stack, with a certain shape of base, and a short smoke box no longer than the cinder pocket would require.''

Prior to a consideration of more prominent examples of present practice, the latest forms of the diamond stack front end may be referred to. Figs. 6 and 7 illustrate that which is applied on large consolidation engines recently built by the Brooks Locomotive Works for the Union Pacific railroad, and which is substantially similar to that referred to by Mr. McConnell in his remarks at the 1894 convention above noted. The construction does not present any substantial features of novelty, but is fairly representative of this general type. The blue print which is illustrated in Figs. 6 and 7, was furnished by Mr. McConnell, with a letter of

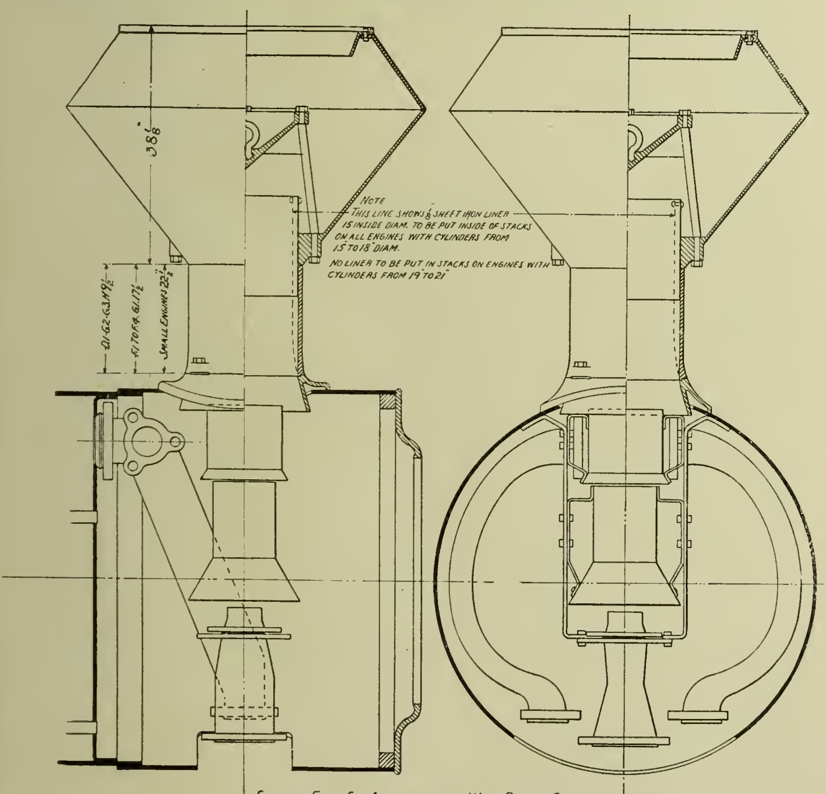


FIG. 8. FIG. 9.

April 4, 1899, in which he does not call attention to any particular of special design or detail of the front, but gives a clear and interesting statement of the experience of the Union Pacific in connection with front ends, the concluding paragraphs of which, showing the continued satisfactory service of the short front and the diamond stack are as follows :

"In 1891 we commenced the removal of the front ends and applied diamond stacks to all of the engines as fast as they went through the shops. The effect of this was immediately noticeable in the steaming of the engine, and in the decreased consumption of coal. At the same time we commenced increasing our train haul. We find our engines steam freer, we could always depend upon them, and we were enabled to open up the exhaust nozzles, thereby increasing the effective power of the cylinder by reducing the back pressure. We had less trouble with leaky steam pipes. The number of engine failures on account of steam were very largely reduced, and there was a large decrease in the amount of coal consumed per mile.

"Have talked with a number of superintendents of motive power concerning the longer extension, and do not find among any of them a claim that the long extension is as economical on fuel as the short front end and diamond stack; the principal claim being that it is modern, and the engine and train is cleaner, as the sparks are thrown so high that they clear the train; and in a great many instances they were applied to locomotives because some of the competing roads applied them. Others went on the principle that theoretically it was the correct principle, regardless of the fact that it was costing more for fuel to operate the locomotives than the old form of front end and stack. Am disposed to believe there are a number of men in the country now who are somewhat dissatisfied with the device and when the proper time comes will make a change in it."

Mr. McConnell is understood to be conducting tests as to the practicability of employing an open stack with a short smoke box, but this fact, if it be a fact, or the adoption by him of a front of such character, if it should be found suitable with the class of fuel used on his road, would in no degree be at variance with the views expressed by him as to the relative merits of the short and long smoke box.

Figs. 8 and 9 show a diamond stack, which is the standard for all wood burning engines on the Mexican Central system. While this front end is generally similar to that of the Union Pacific, it differs radically therefrom, and from all other constructions of this type, in the particular that no netting whatever is used n the stack or smoke box. Mr. F. W. Johnstone, superintendent M. P. & M., Mexican Central railway, personally informed the writer that he has found the construction entirely satisfactory in service, engines steaming freely and not throwing fire. In a communication dated May 12, 1899, he confirms the position taken by Mr. McConnell, his views as to smoke box length being expressed in the following extract from his letter:

"I cannot very well give you any comparative tests between the short ends and the standard front end, as we have not used any extended front ends for ten years. I found out early in the game that they were no good, and did away with them.

"About 12 years ago we got some engines built with extended front end. When we were obliged to turn these engines into wood, I found it necessary to put in a partition in the front end, reducing the area, before we could get the engines to do any good at all, although we made every conceivable change before resorting to this expedient. This convinced me that the extended front end was a failure, and we soon had all our engines changed back to the short front end, and did away with the useless cinder pot."

The committee on "Exhaust Pipes and Steam Passages," again submitted an elaborate and valuable report, at the twenty-ninth annual convention of the American Railway Master Mechanics' Association, 1896. For convenience of reference and comparison with examples of recent construction, which will be hereafter

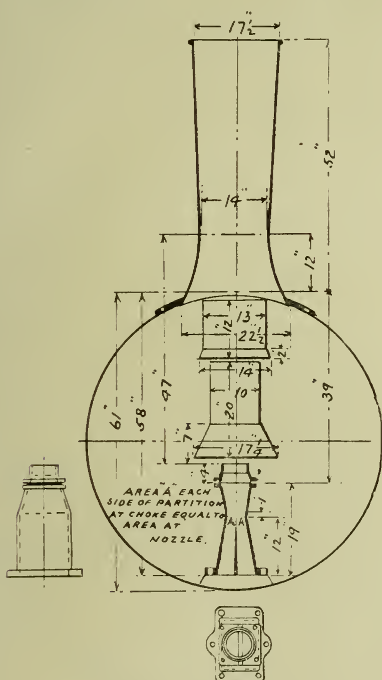


FIG. 10.

given, Plate 48 of this report, which shows the arrangement of exhaust pipe, nozzles, and stack which the committee found to give the greatest efficiency, is here reproduced as Fig. 10.

While, as before indicated, the committee recommended that the smoke box be made sufficiently long to permit a cinder pocket or cinder pot for the discharge of cinders, to be located in front of the cylinder saddle, the general recognition of the fact that the smoke box, whether long or short, could not and did not in practice, perform to any extent the function of a cinder *receptacle* or retainer, suggested the inquiry as to whether or not a cinder-discharging appliance was of any substantial utility. This was the subject of Topic No. 2: "Is it possible to arrange the front ends of locomotives so they will clear themselves of cinders without throwing sparks," at the thirty-first annual convention of the association, 1898. (Proceedings, pp. 103-108). It was sufficiently demonstrated that the question could be answered in the affirmative, the means employed being an extension of the deflecting plate or diaphragm, to a point in front of the exhaust pipe. This

modification, as embodied in instances of recent practice in which the cinder pot is dispensed with, will be illustrated hereafter.

An interesting contribution to the literature of the subject under consideration is to be found in the paper entitled, "Draft Appliances on Locomotives Exhibited at the World's Columbian Exposition," presented by Mr. Willis C. Squire, at the meeting of the Western Railway Club, November 21, 1893, and published in its Proceedings for that month (pp. 52-77). The ruling practice at that date is very

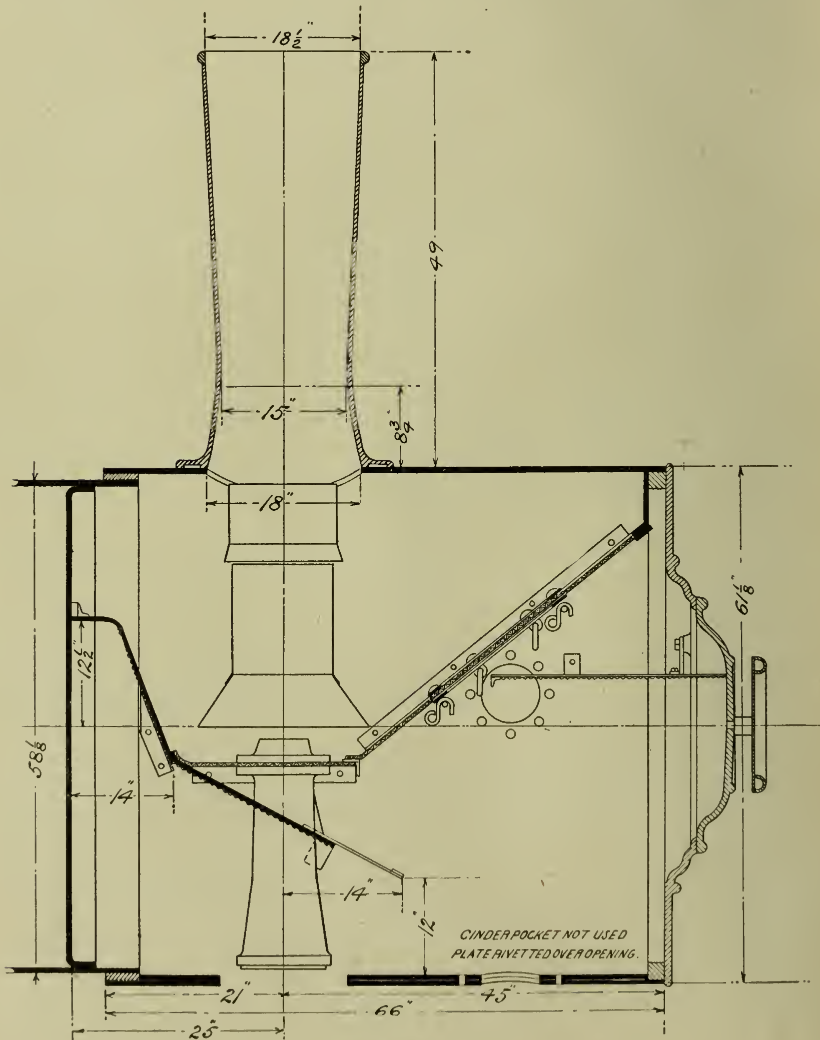


FIG. 11.

fully described and illustrated, and a basis of comparison with the examples of present practice, which will now be considered, is clearly outlined.

The recommendations of the 1894 report of the committee on "Exhaust Nozzles and Steam Passages," met with general and continued favor, and have been adopted to a considerable extent, with satisfactory and approved results in service. The fact that the sixth conclusion, as to the shortening of the smoke box, has not been accorded with as promptly and generally as the other features of detail, is due largely to the fact that many of the long smoke boxes were made in sheets of a single length, which it was inconvenient to shorten, and that motive power officers were reluctant to incur the delay and expense of removing the long separate extension and substituting a shorter one. Force of habit and hesitancy to depart from the cherished traditions of the supposed advantages of the extended smoke box, were also, doubtless, factors of no inconsiderable weight. We therefore, find the construction of the committee adopted with both long and short smoke boxes, and now pass to the consideration of these and other instances of recent practice.

The application of the Master Mechanics' Association design in connection with an extended smoke box, is shown in Fig. 11, which illustrates the standard front end of the Michigan Central railroad. The extension of the deflecting plate in front of the exhaust pipe, before mentioned as having been discussed at the 1898 convention, as a means for clearing the smoke box of cinders, is employed in this construction, and the cinder pot or pocket is dispensed with, a plate being riveted over the opening, in cases where the cinder pot was formerly used. The utility of the extended smoke box in engines which are designed to, and in practice do clear themselves of cinders, is not apparent, and the reason for its employment is not stated in the letter of Mr. Robt. Miller, superintendent M. P. & E., M C. railroad, transmitting blue print of the front, dated March 31, 1899, in which he gives the following statement of his views and practice :

"I take pleasure in sending you blue print of the front end in use on the Michigan Central road. As stated in conversation there is no accumulation of cinders in the front end of Michigan Central engines equipped in this manner. It has not been the effort of this department to throw the cinders out of the stack, but to retain them in the firebox as much as possible. I do not believe a device was ever made that would entirely hold them. If there has been, I have not been fortunate enough to see it. However, I think we have been fairly successful in reducing it to the minimum. Experiment has taught me that a nozzle should be as large as the area of the exhaust opening, and never reduced below that point. Reducing the choke in the stack will have the effect of increased draft in the firebox the same as reducing the size of the nozzle, and at the same time will have the advantage of not causing back pressure. I believe I have followed the recommendations of the committee of 1896 of the Master Mechanics' Association on this subject, and have every reason to believe that by so doing I have accomplished as good results as could be obtained."

Mr. S. M. Vauclain, of the Baldwin Locomotive Works, has furnished ten blue prints illustrating different forms of front end constructions applied by his firm on engines built by them, regarding which he says : "You will notice that some of these are so-called self-cleaning devices, or spark atomizers, and require

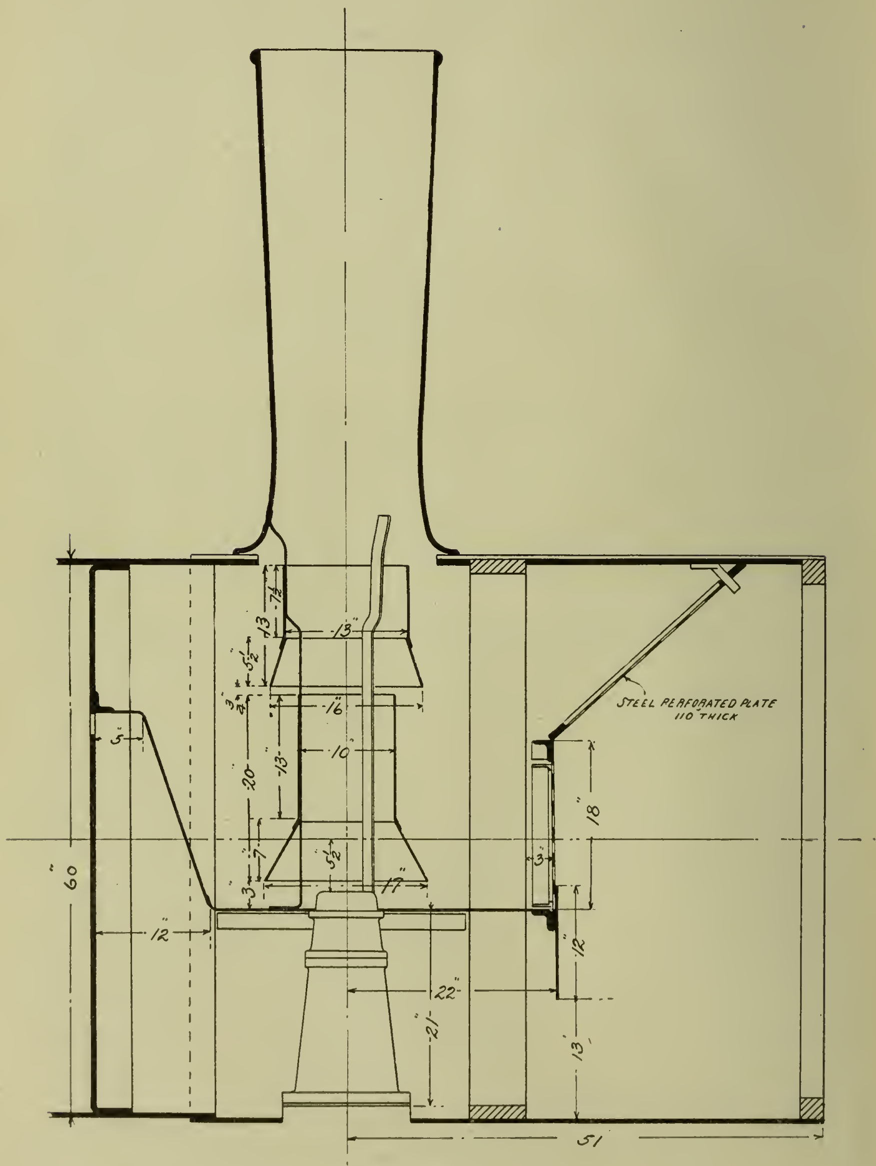


Fig. 12.

no cleaning at the end of a trip or for any number of trips. The dirt is thrown out but the fine particles only escape. I can give you no definite data on any of these systems. I am informed that each and every one of them is just right, and could send you more than a hundred others, also just right, so I decline to say which is the very 'rightest.' "

Mr. Vauclain's blue prints all show extended smoke boxes, deflecting plates or diaphragms, and netting above and in front of exhaust pipe. Four of them substantially accord (except as to length of smoke box) with the Master Mechanics' 1894 design, and four are of the self-cleaning type, with forward extension of the deflecting plate. No features of special novelty or interest appear, and they are not therefore reproduced.

Fig. 12 shows the self-cleaning front end used on Class U engines, Norfolk & Western railway, regarding which Mr. W. H. Lewis, superintendent of motive power writes, under date of April 10, 1899, as follows:

"I take pleasure in enclosing you blue print mentioned, also revised blue print C 5262, showing practically the same arrangement with the low nozzle and double lifting pipes; both arrangements have proved entirely satisfactory, although in our service my preference is for the higher nozzle, as it affords a better opportunity to reach the flues in the front end, besides saving additional expense of the lifting pipes and their attachments.

"The self-cleaning feature of these are practically the same, and we have found that it is possible to do away entirely with the spark hopper and blower, and experience no trouble with the front filling with sparks.

"I beg to remind you, however, that the general rules to be observed in the arrangement of these spark-arresting devices are largely dependent upon the character of the coal and the service performed by locomotives, and the position of the deflector and diaphragm plates can only be determined by a careful service test The satisfactory results which we are now obtaining have thoroughly convinced us that it is not necessary to maintain a long extended front as a receptacle for sparks, and that only sufficient extension is required to insure the proper area of opening in the perforated plates or netting used to insure a free draught; in fact, in the number of observations which we made prior to the adoption of the device, it was found that our long extended fronts accumulated the maximum amount of sparks in a distance of ten miles, in heavy mountain service, which represented that all of the sparks which entered the front end after that time were necessarily thrown out. We, therefore, felt that little advantage might be expected from simply storing the sparks that would accumulate in going a distance of ten miles and running a further distance of fifty or sixty miles without any further accumulation, and that it was thoroughly logical to adopt a device which would relieve the front of sparks entirely."

Coming now to constructions in which a comparatively short smoke box, or one not longer, or materially longer, than is recommended by the Master Mechanics' Association in 1894, is employed, Fig. 13 shows the front end used on classes A, B and C engines of the Chicago, Burlington & Quincy railroad, all American type engines, with cylinders varying from 15 x 22 to 18 x 24, and may be taken as generally exemplifying the class in which a high exhaust nozzle is applied, without a petticoat or lift pipe. This arrangement, more or less modified in detail, is

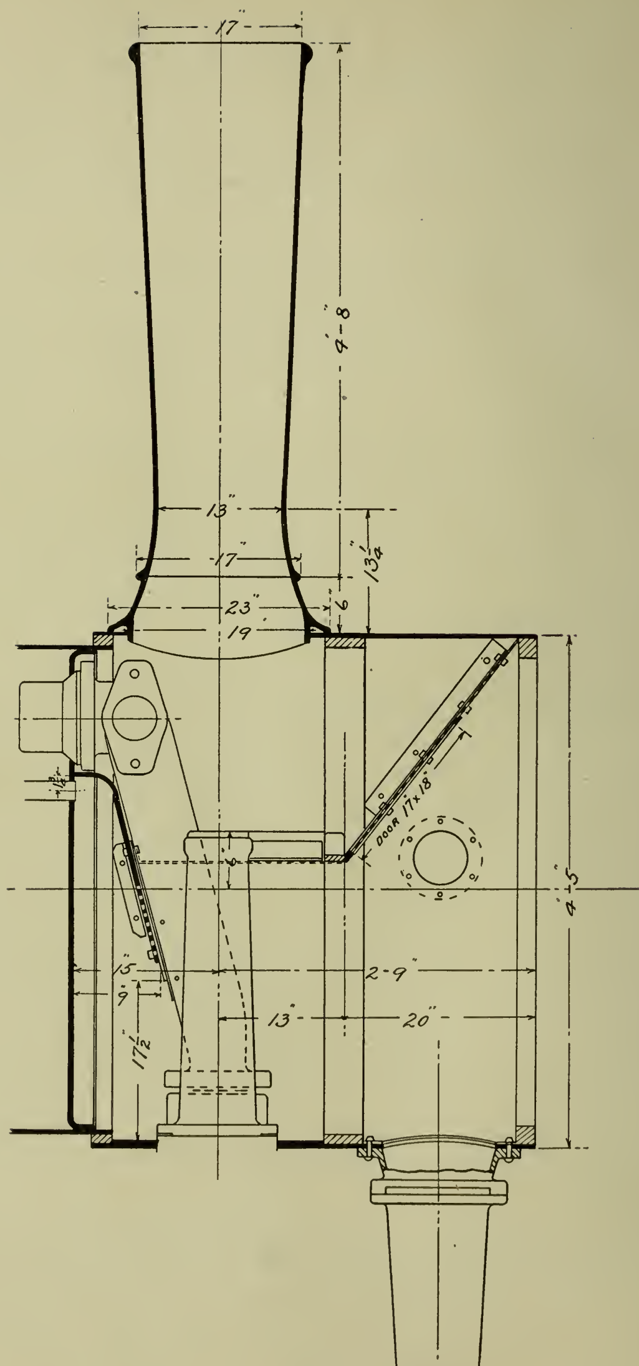


FIG. 13.

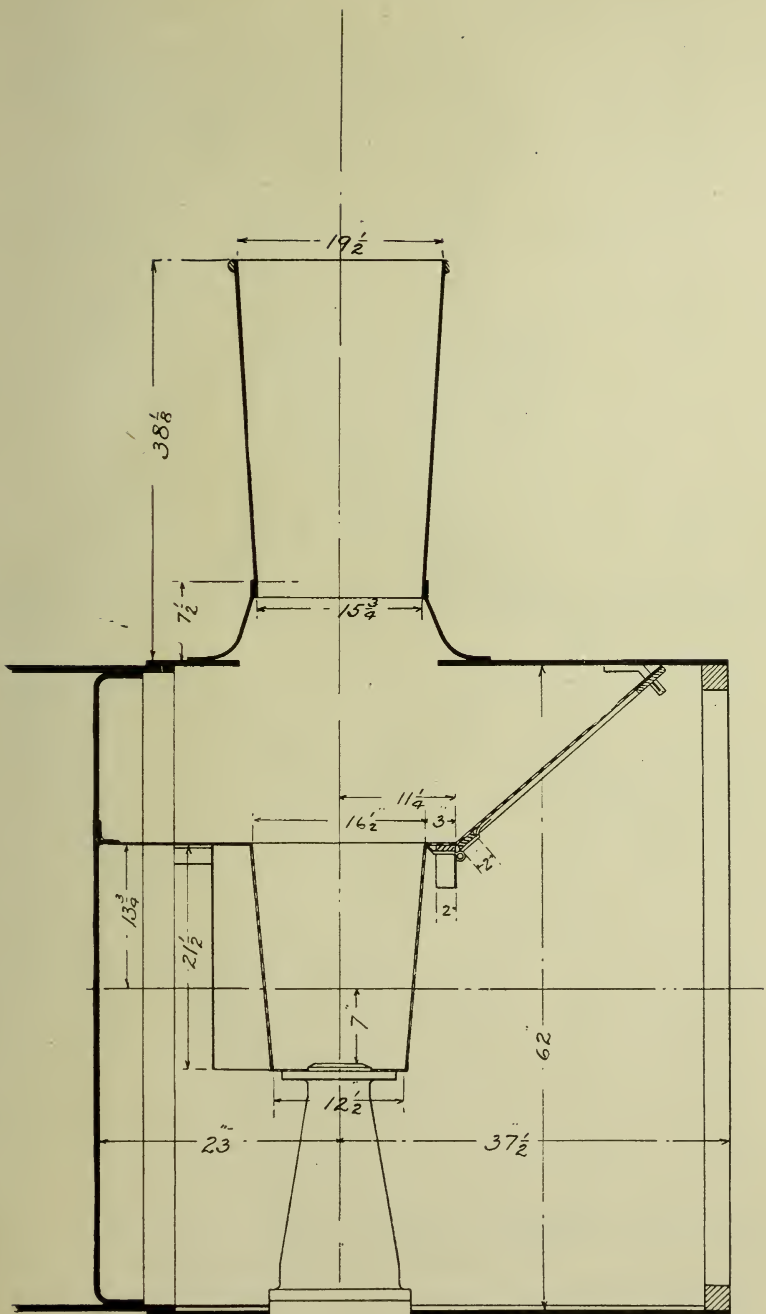


FIG. 14.

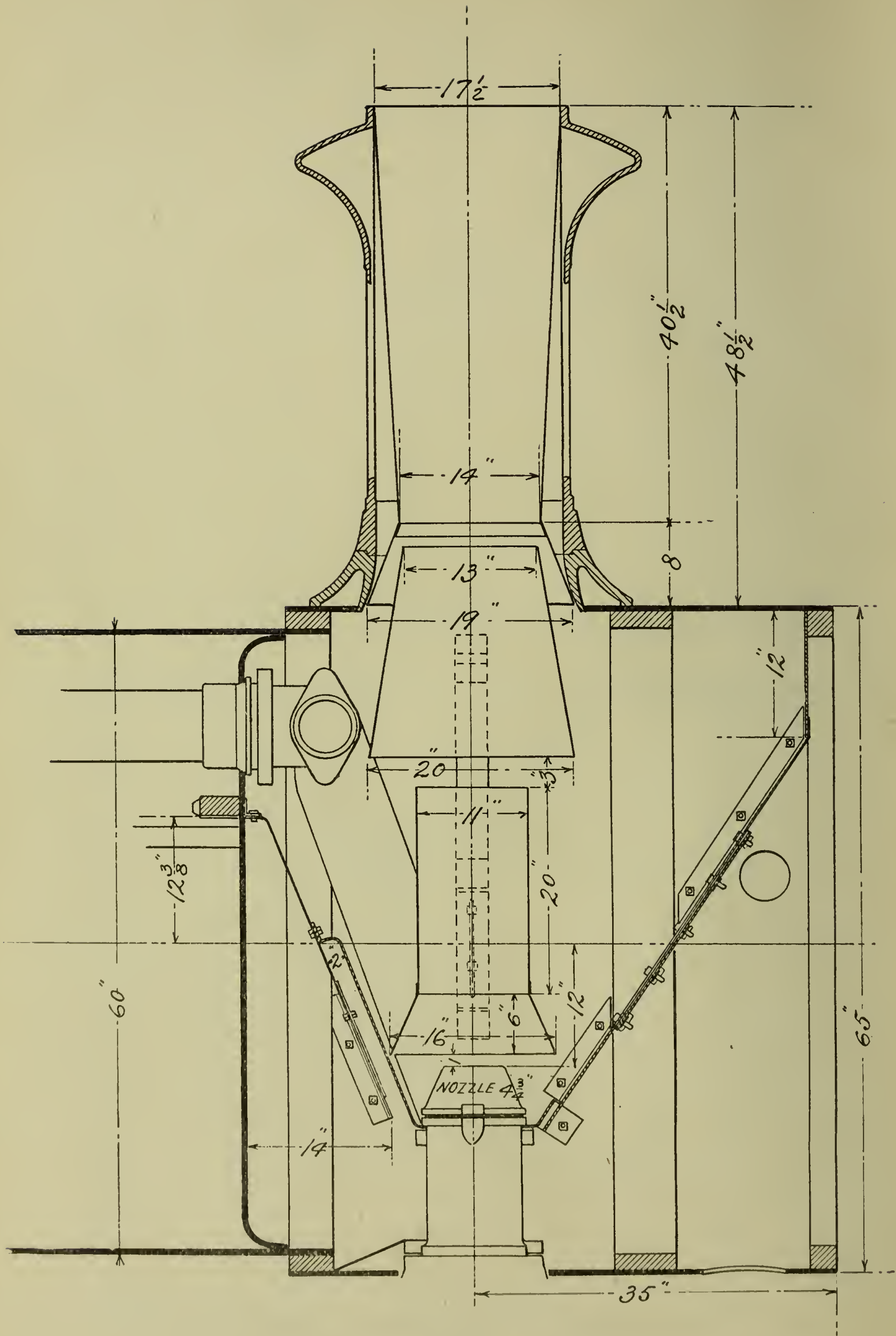
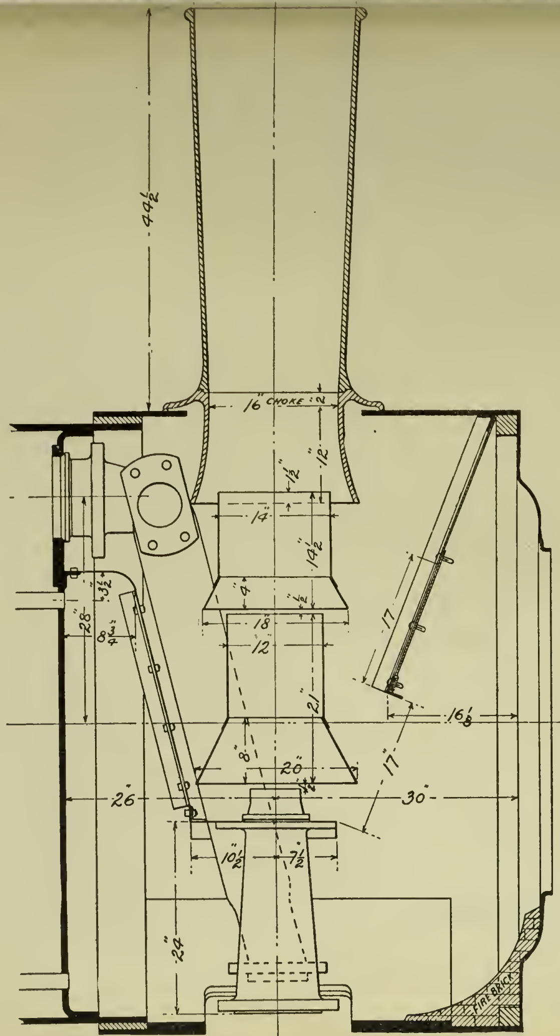
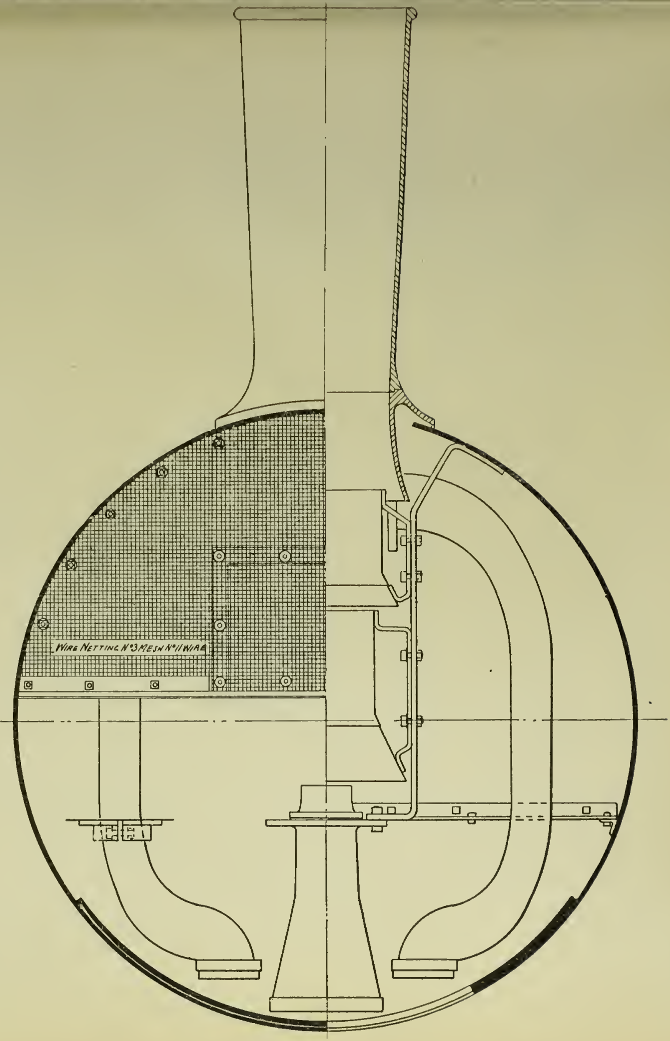

17½
14"
13"
19"
20"
11"
3"
20"
6"
16"
12"
1
NOZZLE 4¾"
2"
14"
12⅜"
60"
40½"
48½"
8
12"
65"
35"

Fig. 15.



44½
16" CHOKE : 2
12"
1½"
14"
14½"
4"
½"
18"
12"
21"
8"
20"
½"
3½"
28"
8¾"
26"
17
16⅛
17"
30"
10½"
7½"
24"
FIRE BRICK

Fig. 16.



WIRE NETTING Nº3 MESH Nº11 WIRE

Fig. 17.

extensively used throughout the United States, with both long and short smoke boxes. The deflecting plate is, in this and many other cases, perforated, but is usually without perforations.

Fig. 14 illustrates the front end of the new Atlantic type engines, Nos. 1591 and 1592, of the same road. In this case, which shows the views of the builders, a "basket" or truncated cone of netting reaches from the top of the exhaust pot to a plate extending to the flue head and a front inclined sheet of netting. The above illustrations are selected from a number of blue prints furnished by Mr. F. A. Delano, superintendent of motive power, who calls attention to the fact that there is considerable divergence of opinion as to what is the best, and that master mechanics have been allowed to follow their own ideas to a considerable extent. The "basket" form of netting, as in Fig. 14, appears to be preferred in these designs when a low exhaust nozzle is used, and one of them, which practically corresponds with that shown in Fig. 13, except that the netting is curved upwardly, instead of being inclined, and that a longer smoke box is used, is stated to be applied to about sixty locomotives on one of the divisions of the C., B. & Q. railroad, and to be thought a good design. Mr. Delano also states that he uses brick arches in all his engines, and that he believes in as high an exhaust nozzle as will give sufficient draft, and as large a netting area as can be used.

A front end which has been substituted, with entirely satisfactory results, for long extended smoke boxes, in a number of engines on a prominent railroad, is shown in Fig. 15. The motive power officer in charge, who is recognized as good authority, but who, for satisfactory reasons, does not desire to be named, forwarded the blue print from which the illustration was made, with a letter of March 28, 1899, in which he says:

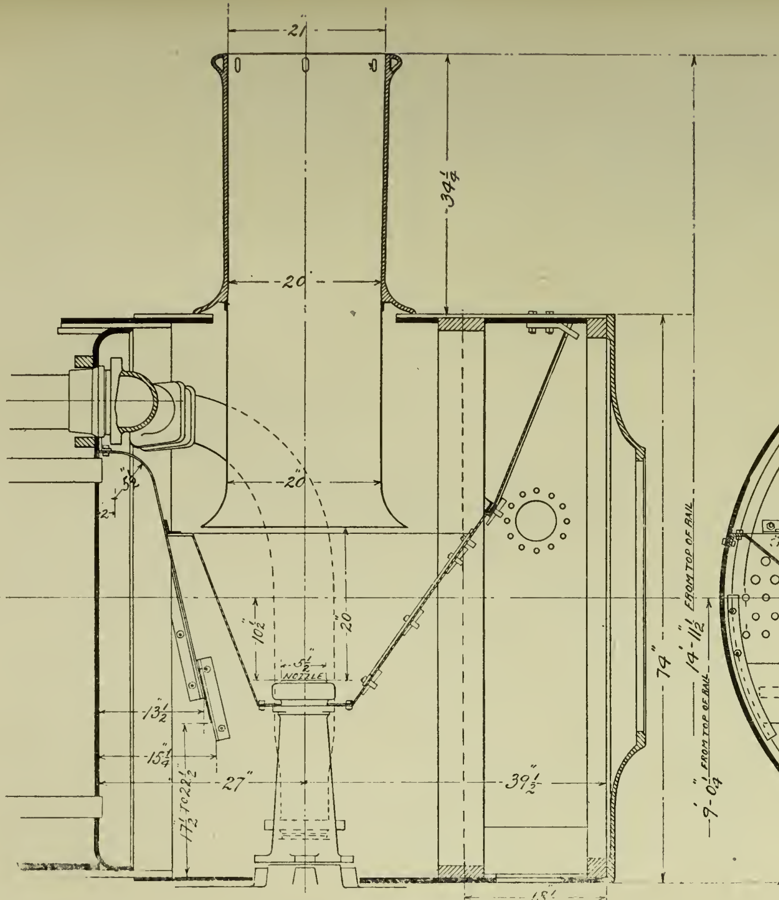
"We have shortened the front ends on a number of our locomotives for the purpose of enabling the nozzles to be enlarged, which we found by experiment could be done when the front ends were shortened. The design of front end arrangement we use, is practically the same as that recommended by the committee of the Master Mechanics' Association two years ago, and we have found it quite satisfactory. We, of course, made some slight modifications to suit the different conditions under which they were applied.

"We cannot give you any reliable figures on the performance of the locomotives before and after the extensions were shortened, as the conditions of the service have changed from time to time sufficiently to vitiate a comparison of the coal consumption during the different periods."

Figs. 16 and 17 will be fully understood by reference to the following extract from a letter of Mr. F. W. Johnstone, superintendent M. P. & M. Mexican Central railway, dated May 12, 1899:

"I take pleasure in sending you blue print, showing front end arrangement of the new engines which we are getting built by the Baldwin Locomotive Works, our card 726, drawer 28.

"You will see that we are using the master mechanics' standard nozzle and petticoat arrangement, with what we call the Mexican Central standard deflecting plate and netting arrangement. This gives a clear opening between the bottom of the netting and the top of the deflecting plate of seventeen inches.



21"
20"
20"
34¼
20"
10½"
5½"
NOZZLE
5½"
2"
13½"
15¼"
17½" TO 22½"
27"
39½"
18½"
79"
14'-11½" FROM TOP OF RAIL
9'-0¼" FROM TOP OF RAIL

Fig. 18.

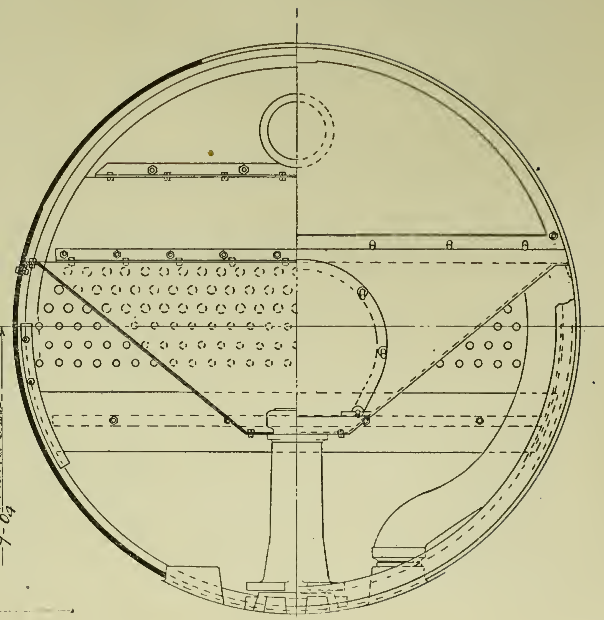


Fig. 19.

"We have ten consolidation engines built on the same lines as the new ones we are now getting built, which are equipped with this front end and smoke stack. The engines steam freely, are economical in the consumption of fuel, and do not throw fire.

"The G 2 engines are the same as the G 3 now being built by the Baldwin Locomotive Works. They have 21 x 26-inch cylinders, 55-inch drivers, 160,000 pounds on the drivers."

The general direction of the present ruling practice in front ends is plainly marked in the abandonment of the long extended smoke box by the Pennsylvania railroad in its latest and most improved designs of locomotives, for both fast passenger and heavy freight service. Figs. 18 and 19 show the front end arrangement of the large H 5 and H 6 consolidation engines, recently built by that company, and the same design, in all substantial particulars, is used on their latest construction of high speed passenger engines, these being of the "Atlantic" type, with Belpaire top wide firebox, known as Class E 1.

In a letter of June 8, 1899, Mr. F. D. Casanave, general superintendent motive power, makes the following statement :

"Our knowledge in the development of the front ends of locomotives has been obtained very gradually by general experiments. The general design of the front end of our locomotives consists of an exhaust pot to about the center line of the boiler, and is in no particular different from the arrangement commonly in use

"From my observations, the best conducted experiments in the development of the front end of locomotives were carried on by the Master Mechanics' Association, and printed in their Proceedings of 1896. I am sure you will at once see that these gentlemen have given the subject a good deal of thought and study, and I find that I have practically nothing to add."

In view of the fact that this front is doubtless practically self cleaning, and of the comparatively large diameter of the smoke box, it may be suggested that it could, with advantage and without sacrificing any netting area, be further shortened, as, say, ten inches or thereabouts. Again, if a cinder pocket is believed to be desirable, with this or any other design of front, it would seem that if its smoke box opening were made oblong, with the greater dimension transverse to the engine, the free discharge of the cinders would be facilitated, and the length of front necessary to accommodate it be diminished. Among other meritorious features of this design, attention may be called to the disposition of the netting, whereby as great an area as is practicable within a determined length of front is obtained, and the sheets are inclined relatively to the traverse of the escaping products of combustion. The inward extension of the stack, while by no means a novel feature, having been applied in English engines as early as 1860, is also believed by the writer to be of substantial practical value. There can be no doubt of the efficiency of this front, both as to free steaming and prevention of fire throwing, and it has been not an unimportant factor in the phenomenal performance of the E 1 passenger engines on the Camden & Atlantic railroad, in July last, which is reported in the *Railroad Gazette* of August 11, 1899. It will, however, be recognized that in these engines the front is less heavily taxed, as to spark arresting duty, by reason of the large increase of grate area attained by the employment of the wide firebox.

The Turner, Coburn, and Bell front ends may be referred to as representative of that class of designs, the leading characteristic of which is a reduction of smoke box length when a plain open stack is employed. Each of these has been applied and is now in service on a sufficient number of engines to entitle it to consideration.

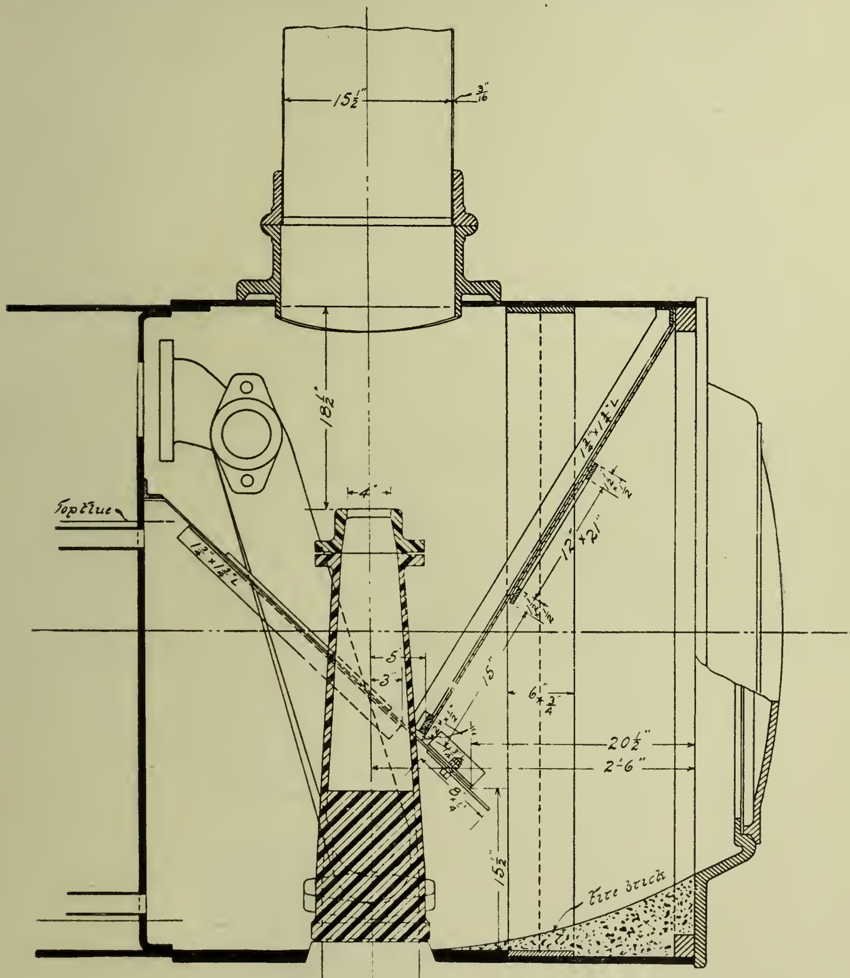


Fig. 19a.

The Turner front, designed by Mr. J. S. Turner, superintendent motive power, Fitchburg railroad, and applied by him to engines on the Mexican Central and West Virginia Central & Pittsburgh roads is self cleaning and uses no cinder pot. The distance from center of exhaust pot to front of smoke box is thirty inches, a high

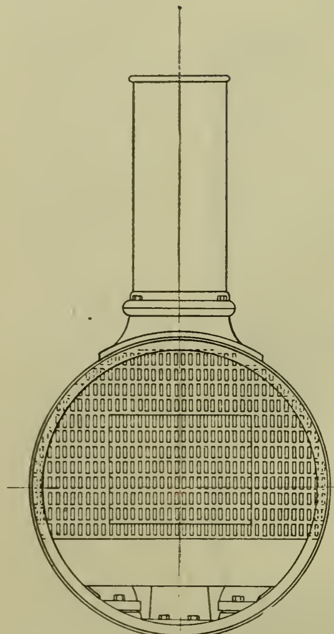


Fig. 20.

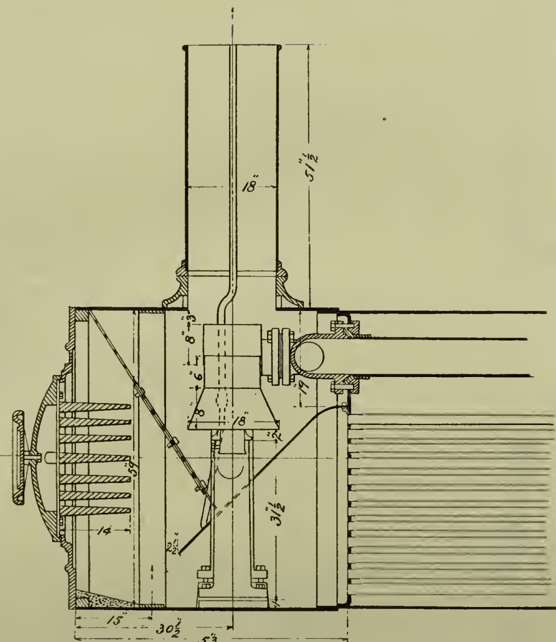


Fig. 21.

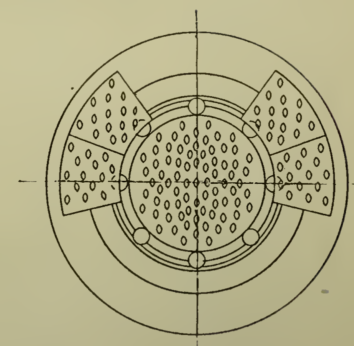


Fig. 22.

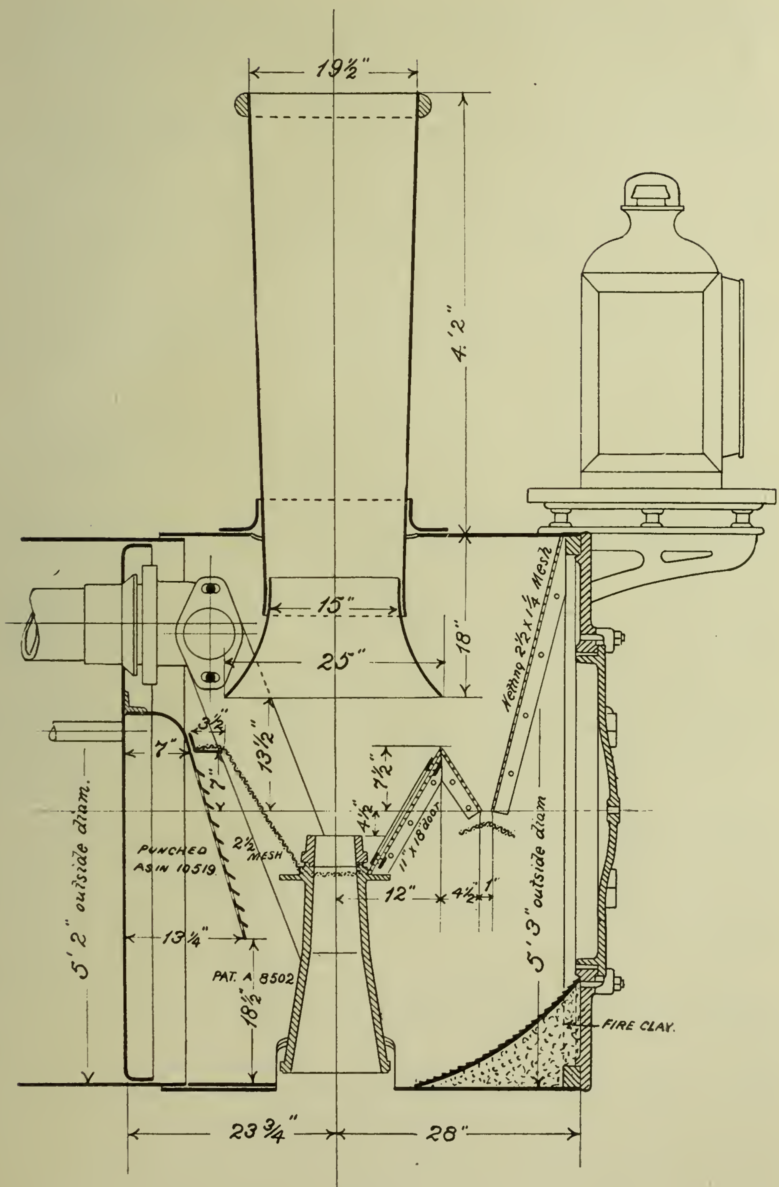

19½"
4' 2"
15"
25"
18"
Netting 2½ x 1¼ Mesh
3½"
7"
7"
13½"
7½"
4½"
11" x 18" door
2½ MESH
PUNCHED AS IN 10519
12"
4½"
1"
5' 2" outside diam.
5' 3" outside diam
13¼"
PAT. A 8502
18½"
FIRE CLAY.
23¾"
28"

Fig. 23

nozzle is used, and the inside appliances are an inclined deflecting plate extending from above the top row of tubes to a line about eight inches in front of the center of the exhaust pot, and an inclined sheet of netting running from the deflecting plate to the top and front of the smoke box. Mr. Turner states that engines equipped with this front, steam more freely and are lighter on fuel than those in the same service having the ordinary extended smoke box. He summarizes the advantage of the short self-cleaning front end as being: (1) Reduction in the length of front end and discarding spark hopper. (2) Bottom steam pipe joints and bolts, cylinder saddle strengthening sheet and saddle bolts, and front end ring and door will not burn and warp, as it completely prevents an accumulation of hot sparks or cinders. (3) No delay on the road caused by stopping to clean front end, and no cleaning at terminals, consequently preventing dust and sparks getting in the truck boxes, and blowing over the locomotive and machinery. (4) Prevention of fires to property along the road. (5) Locomotives will steam more freely and show economy in fuel. Fig. 19 a shows the Turner front end as applied to, and in service, on locomotives of the Fitchburg railroad.

The Coburn front end which is shown in Figs. 20, 21 and 22, was designed by Mr. W. P. Coburn, master mechanic, Chicago, Indianapolis & Louisville railway. The arrangement of deflecting plate and netting is practically identical with that of the Turner front above noted, and the novel feature of the design is a so-called "spark breaker and extinguisher" which is composed of castings thickly studded with projecting fingers fourteen inches long, and bolted to the inside of the smoke box front and door. The cinders, in passing these projections, which are staggered, impinge against them, and are broken up and their life destroyed. The device is obviously a self cleaner and no cinder pot is used. In a letter of April 8, 1899, Mr. Coburn says:

"We have now about seventy-five engines equipped with short front ends and 'spark devices.' Our engines are steaming better with short front ends and burning less fuel. We have not made an accurate test between the short front end and the extension, but we know that we are getting good results. We have increased the size of our exhaust tips from one-eighth to one-fourth in all engines that we have turned out with short front ends. We are using a run of mine coal, a very poor quality of fuel, and our comparative statements show that we are making an increase per car mile hauled, over the engines with the extension fronts; besides we do away with all the dirt from the engines, making a saving on oil, engine trucks and machinery."

The Bell front end, designed by the writer, as in service in 21x26-inch consolidation engines on the Baltimore & Ohio railroad, is shown in Fig. 23. In later applications, on this road and on the Pittsburgh, Bessemer & Lake Erie railroad, an addition has been made to the lower end of the deflecting plate, extending, on a slight incline to a line in front of the exhaust pot, on the same principle as that of the self-cleaning fronts before referred to. The deflecting plate is punched, with lips projecting toward the front from the holes, and a sheet of netting is placed in front of it to intercept any cinders that may pass through the holes. The main portion of the netting is set in three planes or in "saw tooth" form in front of the exhaust pot, so as to present approximately vertical surfaces to the cinders as they pass up from below the deflecting plate,

and a 1-inch clear opening, protected by a lower sheet of netting, is left between the two front inclined sheets to prevent clogging by accumulation of cinders between them.

Mogul engines, 19 x 24 cylinder, on B. & O. railroad, equipped with this front are running with $4\frac{5}{8}$-inch nozzles, as compared with $4\frac{1}{2}$-inch nozzles on similar engines in similar service having the ordinary extended smoke box, and they are reported as steaming freely, economizing fuel, and not throwing fire to an objectionable extent. Consolidation engines with 22 x 28-inch cylinders, on P., B. & L. E. railroad, having this front, are reported as "giving excellent results as to steaming" and being "particularly good steamers."

The front end above described has been modified by the Brooks Locomotive Works, by the application of solid longitudinal plates attached to the sides of the smoke box, the bottoms of which come inside the steam pipes, and the sides of which form the ends of the netting chamber. As so modified, they have applied the Bell front to about 150 locomotives recently built by them, including the large 12-wheel locomotives of the Great Northern railway; 10-wheel locomotives for the Wisconsin Central, consolidations for the Bessemer (P., B. & L. E.) and others, all of large size and latest improved design.

It cannot be doubted that the subject of locomotive front ends is of such substantial importance to motive power officers as to merit a higher development than it has yet reached, and that such development will, under intelligent and thorough investigation and test, be speedily attained. It is equally obvious that the extent of the subject and the widely varying conditions of fuel, service and structural limitations under which it must necessarily be considered, preclude its discussion here further than, as has been attempted to be done, upon the general lines of a comparison of past and present practice, and a review of the expressions of the Master Mechanics' Association regarding it. Upon this basis, as well as upon a study of the mechanical principles which seem properly applicable, the writer submits the following conclusions:

1. That a smoke box of greater length than is necessary to permit the use of a sufficient area of netting to provide for free steaming, is not only useless but also positively prejudicial, as to the steaming of the engine and economy of fuel.

2. That, particularly with boilers of the present average diameter, the length from center of exhaust pot to front should not exceed, say, thirty-five inches, and that all necessary netting and draft appliances can be properly applied in a smoke box of such length.

3. That the front end should be of what is known as the "self-cleaning" type, and that the cinder pot or cinder hopper is wholly useless and a needless addition to the cost of the engine.

4. That where an open stack is employed, the taper or "choke" pattern will, if properly designed and proportioned, be more usefully and economically effective than a "straight" or cylindrical stack.

5. That the construction recommended by the American Master Mechanics' Association at its 1894 and 1896 conventions, embodies, as a whole, the most desirable and effective plan or design, under the general principles and conditions applicable to and controlling in locomotive front ends.

6. That, under certain conditions, the design of front end embodying a short smoke box, a diamond stack, low exhaust pot, and lift pipe, is as usefully and effectively applicable as that of the Master Mechanics' Association.

7. That the useful and economical effect of a locomotive front end is wholly and solely dependent upon the draft appliances and spark arresting devices employed, and that such effect will be reduced proportionately to any increase of smoke box length beyond that necessary for the application of said appliances and devices.

8. That experimental research can be advantageously made in the directions of: (a) ascertaining what reduction of smoke box length is practicable; and (b) whether or not an appliance can be produced whereby cinders may be returned to the firebox in a practically useful manner.

The President: If Mr. Bell is present, we will be pleased to have him review his paper. Mr. Bell not being present, I will ask Mr. Manchester to review it.

Mr. A. E. Manchester (C., M. & St. P. Ry.): Mr. President, I am sorry that you have found it necessary to call on me to open the discussion on this paper. I have read the paper through once, not as carefully as I should have done in order to open the discussion. Then another thing; some one who has had experience directly in the line of the recommendations of this paper can, I believe, review it more satisfactorily than I can. I find the paper to be interesting and it will be a useful reference paper in a mechanical library, it being quite an able history of the spark-arresting arrangement in the front end of a locomotive, from the start-out with the locomotive up to the practice of the present day.

The paper gives on pages 31 and 32 a series of conclusions; the first is: "That a smoke box of greater length than is necessary to permit the use of a sufficient area of netting to provide for free steaming, is not only useless but also positively prejudicial, as to the steaming of the engine and economy of fuel."

I believe if it were not for the spark-arresting features of the front of the locomotive and the question of cleanliness in passenger service, that the front end of the locomotive would be quite different from what it is today, and that really it is these two features that will come up more prominently for discussion in this report than anything else.

In the early history of railroading I have no doubt that they commenced to get into difficulty very soon with setting-out fire, and on

this account we see the early efforts made to arrest the sparks. That same condition continues up to today, but the modern appliances have, I believe, speaking from my own observation, of roads in the West, been vastly improved, and that the number of fires set out by locomotives today is very much less than in the earlier years of my experience in railroading.

The second point that I referred to, cleanliness, is one of great importance with the people who ride on our passenger trains and criticise so severely anything they may find amiss. I believe if there is anything that will irritate a person and make him feel as if he wished he had gone by the other route, it is on a warm summer day to find the car filled with cinders.

As to the point raised by conclusion No. 1, that an extension front long enough to make the necessary steam, is the most economical, I shall have to say, that so far as my own observation and experience are concerned, I cannot agree with this conclusion in the paper. About three or four years ago we applied a diamond stack and a short front end, following the drawing of a leading railroad that was using those appliances then and today ; we carried out their drawing exactly in equipping our engine, and put it in freight service along with engines of the same size in similar service, and kept it in this condition for something over a year, watching closely the results as to economy, and found at the end of the year that there had been no economy, so far as the fuel record of this engine, or cost of hauling 100 tons a mile, were concerned, as compared with the other engines of the same size and class in similar service. Neither had there been any improvements in the engine's fuel record, over what it had made for the years preceding the application of the short front end and the diamond stack.

Things have come to my notice, however, that lead me to believe that a great deal depends upon other conditions in connection with the engine ; that the size of the fire box, the grate area, the length, number and size of the flues, brick arch, whether there are air flues just above the fire, all have a decided influence on what shall be the result obtained with any change. Some few years ago, during a coal famine, our company purchased a few hundred cars of Wyoming coal, to be used in our engines with the extension front and straight stack. We were not at all successful with the experiment. We left a streak of fire all the way across the State of Iowa ; set fire to stock cars, to

stock yards, to depots, to the grass, in fact, we made a conflagration, and we had to call a halt and send the fuel to stationary boilers to be burned. Now, I understand there are people who are able to burn that fuel and not meet with the disastrous results we had. Therefore, I think the quality of the coal may decidedly affect the results to be obtained.

We know this, with the extension front, that we often get hold of coal that is old, has been a long while in the coal house, and has become air-slacked, and find that we get very bad results on account of its filling up the front end too rapidly. I have always believed that we were at least showing something in our efforts at cleanliness, and for prevention of fires, when we brought in ten, fifteen or twenty bushels of cinders and ashes in the front end of our extension fronts, and emptied them in the ash-pit, and our experience has not been in the line of one of the references given in the paper in which it is claimed that the front end filled up in ten miles' heavy service, as much as it would have filled up at all. This is not our experience, except in a very few cases, which are in the line of the fine slacked coal that I have just referred to. We can run fifty, sixty, or seventy miles and gather most of our sparks during that time. If you allow the front end to continue to fill up after that, the engine then becomes very dirty, and commences to throw out an enormous number of sparks and cinders and ashes, and increases its liability to set out fire several fold. While I have had no personal experience, as I said before, with these self-cleaning front ends, it seem to me that when we have filled up our extension front to the point that I have just referred to, then we have turned that extension front end into what would be a so-called self-cleaning front end, and if that is true I do not like a self-cleaning end, because we find that the front ends become dangerous in setting out fires, when they get into that condition, and are also dirty.

The President: Our Secretary has a correction which I would like to have him make.

The Secretary: On page 7, nine lines from the beginning of the first paragraph on that page, is the date, 1860. That should read 1880.

Mr. J. F. Deems (C., B. & Q. R. R.): I have not read the paper over with the care that I would like to devote to it, but it certainly contains a great deal of valuable information and suggestion,

and taken in connection with Mr. Squires' paper, which is referred to, and which I think was read in 1893, gives us a very full and complete history of spark-arresting devices, but there are some points in this paper that impressed me.

On page 5, near the bottom of the page, we find this, which is practically just what Mr. Manchester has mentioned: "it being now generally recognized that practically all the solid matter that passes through the tubes is thrown out of the stack, and that if this can be done without liability to start fires on, or adjacent to the right of way, it is desirable that the smoke box should be cleared by the exhaust."

I am very much inclined to agree with Mr. Manchester on this point. I doubt if that is the correct position. On page 8, in reference to a report made by the Master Mechanics' Association, the writer says: "This report is, however, extremely indefinite and wholly unconclusive, and, as in later discussions of the same subject, treats of the brick arch in fire box as being, in some unexplained manner, related to the extended smoke box." From this we would infer that the writer thinks there should be no connection between the brick arch in the fire box and the extended smoke box. I do not believe that is a correct position. When extended smoke boxes were first applied, fire boxes were much smaller, grate areas smaller, heating surface much more limited, and a much sharper blast on the fire was necessary, and it seems to me that as we come to larger grate area, more ample heating surface, and are enabled to reduce the blast on the fire, that there is a very intimate connection between the brick arch in the fire box and the extended front; and it strikes me that as this goes on, we are reaching a time when the blast on the fire will be so mild that, with properly arranged brick arch, it will be quite possible to apply an extension front that will retain pretty nearly all the sparks, that are carried through the tubes, and it seems to me it is incorrect to claim that there is no connection whatever between the brick arch and the extended front.

On page 9 I find this language: "It is doubtless unnecessary to add that the 'perfect spark-arrester' which the committee, in common with most, if not all, of their brother master mechanics were in search of, has not, up to this date, been discovered." Well, cannot we with equal truth say that the perfect valve motion has not been discovered; that the perfect-counterbalance has not been discovered; in fact, can we not say the same with reference to many other parts of

the locomotive? I doubt, however, if we would be justified in abandoning our present valve motion and go back to the old hook motion, simply because we have not as yet discovered what we would call a perfect valve motion, and it occurs to me that as we are coming to larger fire boxes, just as Mr. Manchester has mentioned, and are enabled to reduce the draft, with ample heating surface, etc., we are going to see the time when we will have an extended front, which is in fact, as well as in theory, a spark-retainer, or receptacle for sparks, and when railroad companies are paying out hundreds of thousands of dollars a year for fire claims it may be well to devote thought to it, and certainly not do anything to discourage development in that line.

In Figs. 16 and 17 is shown the Johnstone front, which is one of the so-called self-cleaning front ends. You will notice the netting that reaches up to the front and top of the smoke box is not connected at the bottom, leaving an open space of seventeen inches for entire width of box, no netting at all being between the bottom of the petticoat pipe and the lower part of the vertical netting. Now, I doubt if we want to try anything of that kind in the western country where there is so much danger of fire. You will also notice in the Turner front end that, although I am not certain but I should say from looking at the cut, there is an opening near the lower part of what may be termed the vertical section of netting, and on the Bell front end, that is, Fig. 23, there is an opening of two inches clear across the entire box, protected below with a piece of netting which is not connected.

I note in the cut of the Bell front, a netting is shown with meshes 1¼x2½. Now, that is certainly quite a liberal opening, and it occurs to me that if these self-cleaning fronts were fitted with netting having 2½x2½-inch mesh, or 2½x3-inch mesh, as is the practice on some western roads, they would very quickly cease to be self-cleaning. My idea is, that the cinders retained in the extension front are those of largest size and most liable to start a fire, and that, for this reason it is quite an element of safety.

Some years ago I experimented with a self-cleaning front, fitted with netting 2½x2½ mesh, with anything but satisfactory results. I also conceived the idea about the same time, of using what is shown in the Coburn front, consisting of a lot of projections, and referred to as a "pulverizer" or "atomizer," but before going into it, decided to try and find out just what was necessary to pulverize these pieces of coke. I arranged an air-blast through a 2-inch pipe with an ane-

mometer to measure the force of the blast, and properly located spikes against which the cinders would be thrown when they came out of the pipe, and after repeating the experiment several times, with blast ranging from two inches to ten inches of water, and throwing the sparks against spikes that were clean and sharp, instead of having a coat of soot to make them like velvet, as must be true in practice on a locomotive, I found the effect quite inappreciable, and, of course, decided not to apply any "pulverizers."

I am firmly of the opinion that as we come to larger grate area, permitting lighter draft and lower rate of combustion, the extension front will be found capable of retaining the few cinders carried to smoke box, between points where they can be cleaned, and will add much to cleanliness of train and comfort of passengers, and also aid in preventing setting out of fires.

The Secretary then read the following communication from the superintendent of the Baldwin Locomotive Works:

PHILADELPHIA, PA., Sept. 16, 1899.

Mr. F. M. Whyte, Secretary Western Railway Club,
Chicago, Ill.:

DEAR SIR—I have received your letter of September 9, and also the pamphlet. It will be impossible for me to be present at the meeting, or to send you a written discussion of the paper.

There are so many devices used, and all doing good work, that I am inclined to think almost anything can be used, but the best results could be obtained without any obstruction at all in the smoke box.

Yours truly, S. M. VAUCLAIN.

THE SECRETARY: In this last sentence Mr. Vauclain, I believe, intends to convey the idea that a front end with no netting in it to obstruct the passage of gases would give the best results, and this is probably true as far as draft and back pressure are concerned, because with 2½x2½-inch mesh, say No. 11 wire, the exhaust must take place through a very small nozzle to produce the same draft through the tubes that would be produced if the mesh were 2x2 or with larger openings. Some roads have taken 2½x2½ with the expectation of breaking up the cinders and reducing the chances of setting fires, and this is a very good reason. Either the cinders must be broken small enough to pass through the netting or they are retained in the smoke box. There are some devices in use in the east which are arranged so that the extension may be cleaned at desirable points on the road.

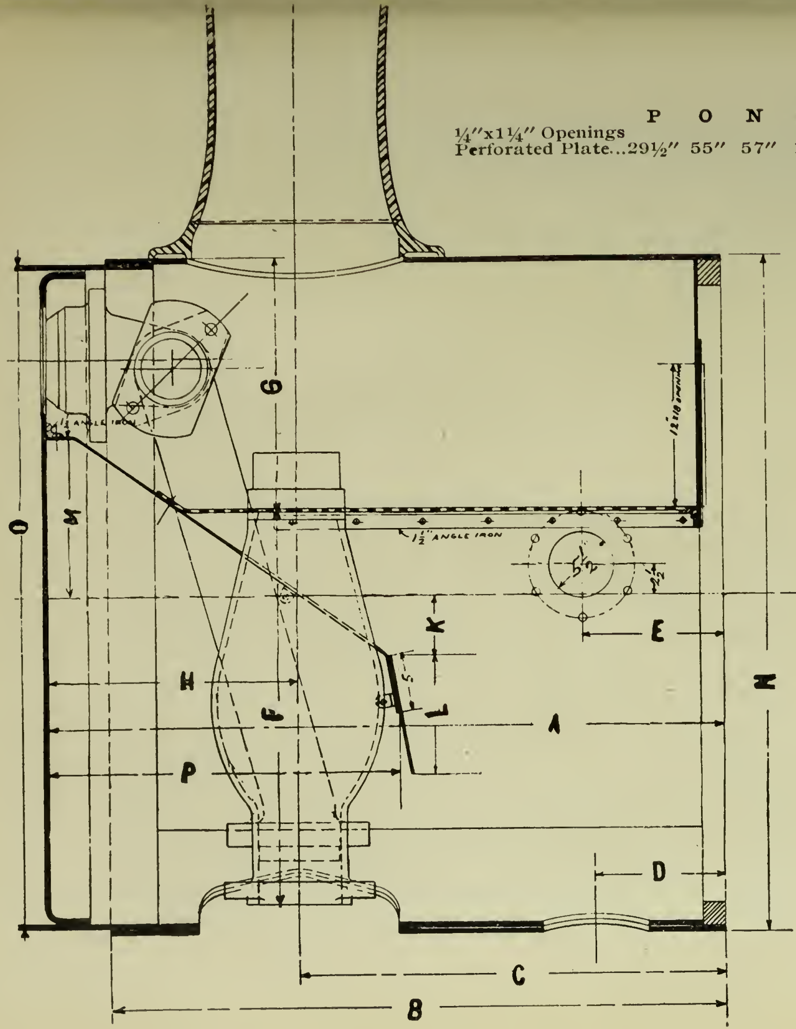
These are in the form of adjustable diaphragms, and when adjusted in a certain position, the cinders, or a larger portion of them, are retained in the smoke box. While running through a section of country in which there is no danger of setting out fire, the diaphragm is dropped and the front end is cleared of cinders. It is claimed that the arrangement gives much satisfaction.

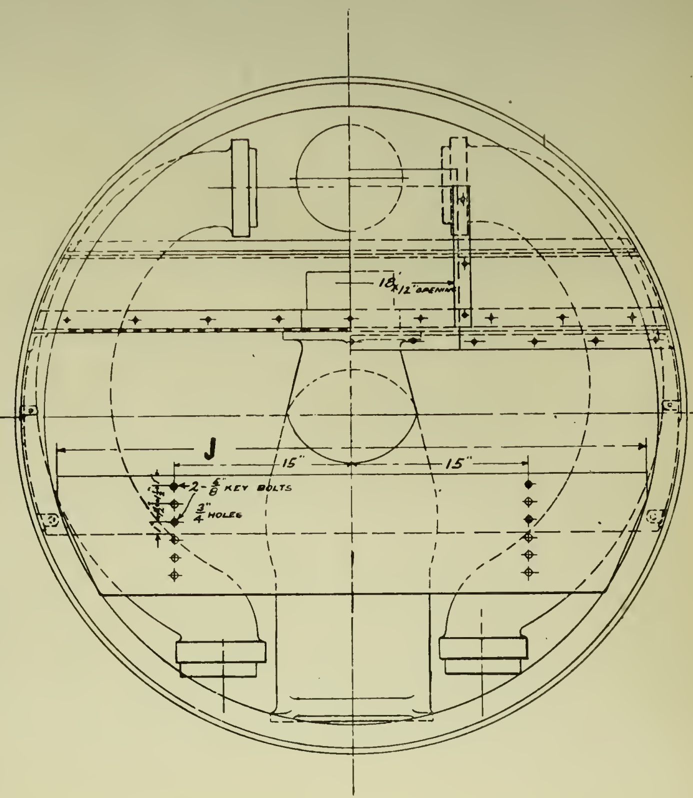
Mr. P. H. Peck : I recollect several years ago, Mr. Briggs, master mechanic at Providence, Rhode Island, used a large cone in a wood burner stack. He had a large pipe running from near the top back through the top of the boiler into the fire box so as to burn the cinders, but I have never seen an engine so equipped ; I have, however, seen a drawing of one. I have tried experiments since I have been in Chicago, with a stack with two fans inside. The fans were run by the exhaust of the engine and carried the sparks back to the ash pan, but the device was a failure. The fans would fill with small cinders and dust and would not work. We are now using a front with which we can handle the sparks in any way desired, by adjusting a diaphragm ; either catching them or throwing them out. We do not want the sparks, but catch them to prevent fires, and it is for that purpose that the sparks are caught in the extension front end.

About twenty-five years ago the Rock Island & St. Louis railroad had a straight stack and small front end. The netting was cone-shaped and extended from the nozzles to the top of the stack so the netting was continuous for the length of stack and front end combined. I never knew of any other road using this device and do not know how it worked, but I do not think it amounted to very much as no other road adopted it. This stack had no cone and was a good steamer.

Mr. Hill (P. & P. U. Ry.) : In 1887, I changed some engines from diamond to straight stacks ; with the diamond stack they were very hard steamers. The change made very free steamers of them. The high nozzle extending a little above the top row of flues was used with a deflecting plate back of the exhaust nozzle, and 3x3 mesh No. 12 wire netting straight across the smoke box just above the top row of flues. The smoke box of these engines was only thirty inches long from flue sheet to front end. No cinder pocket was used. No cinders accumulated in the front ends and we have had no trouble on account of fires. These engines are running in this condition today. The illustration herewith shows the device as used in all engines we

	P	O	N	M	L	K	J	H	G	F	E	D	C	B	A
¼″x1¼″ Openings Perforated Plate...	29½″	55″	57″	11″	10″	5″	50″	21″	21½″	33″	—	—	36″	52″	57″





PEORIA & PEKIN UNION RAILWAY EXTENSION FRONT.

have had built for the past ten years. No cinder pocket for the discharge of cinders is used, notwithstanding the cut shows one. This is explained by the fact that this is an illustration of a builder's blue print and is so arranged to put on cinder pocket for parties who desire it. You will notice in this illustration that I bring the deflecting plate forward of the exhaust nozzle. This gives more area back of the plate and keeps the front end clear of cinders. Instead of wire netting we use perforated plate No. 7 wire gauge thick, with holes ¼x1¼ inches round ends. We find this to be a very satisfactory and economical arrangement. The expense of cleaning out extension front ends is quite an item. On passenger and suburban engines we use the extension front end, catching the cinders and cleaning them out at the ends of the run, This is done as a matter of comfort for the passengers. If on long runs it is found that the front end fills up before getting to the end of the run, a spark ejector can be put on to operate by steam or air and handled by the engineer from the cab.

The President: I hope it will not be necessary to call on the members, but that the discussion will proceed as it has. It is certainly a very interesting subject and one that comes home to us very forcibly, especially when there is a fire in the immediate vicinity.

Mr. F. Slater (C. & N.-W. Ry.): I have given this question of extension front and spark-arresting devices considerable thought and have had considerable experience with it, and I believe that for the protection of any railroad it is necessary to have an extension front, so that you can go into court and show that you have a device for arresting sparks. I have been fortunate, or unfortunate, as you might call it, in being sent to several places to give testimony in cases of fire suits, and the lawyers were always cheerful when they could prove that the company had a modern spark-arrester and could convey the idea to the jury that the company had done everything in its power to arrest the sparks. I have read this report somewhat carefully and agree with Mr. Vauclain that it is useless for a body of men to ever attempt to get a standard front. It will never be accomplished. Everybody has got the best front end. A short time ago I had an engine, on the division that I have charge of, that bothered me for steam. The engine was equipped with the front end recommended by the Master Mechanics' Association, but the engineers would come to me and tell me that the style of front end that they

used on a neighboring road was so much better, and I would send for blue prints and change the front end to that style. I think I tried a dozen different styles and finally went back to the Master Mechanics' front end and got the result that I had before. It was not entirely satisfactory, but it is fully as good as the other front ends tried, so I feel quite confident that we will never get a standard front end which will meet the conditions in every case, because each style of front end contains the notions of the men at the head of the department.

THE PRESIDENT: I think it would be very interesting, and also instructive, if we could have an expression of opinion from the different representatives here of the different roads, as to whether they use perforated plate or wire netting and, if they use wire netting, of what dimension. I think this would add to the interest of the meeting. We will be glad to have information on the subject.

MR. F. A. DELANO (C., B. & Q. Ry.): I had not intended to say anything on this paper; in fact, I have not had time to read it through. It seems to me that the Club can certainly testify their appreciation of Mr. Bell's efforts to ravel out and put in concise shape this very complex question. It is true that every master mechanic has his own views on the subject, and also undoubtedly true that the devices which work well on certain locomotives with a certain kind of fuel, will not work well on different types of locomotives or with the different fuel. Mr. Bell says very truly on page 2: "Any and every spark-arrester is necessarily an attempt to compromise two directly conflicting conditions—one being freedom of draft and discharge of smoke and gases, and the other the prevention of the escape of solid matter in state of ignition from the stack." This, it seems to me, is a very true statement. In the old style front ends with the diamond stack, having low exhaust nozzles, which were extensively used up to 1885, and even since, the idea was to project the sparks, and to shoot them with such force against a cone that they would be broken up, and when they escaped from the stack be too small to do any harm in setting out fires.

The extension front end is certainly a vast improvement over this, to my mind, in that by the use of the high exhaust nozzle the baffle plate and netting at the front end, the sparks or cinders, instead of being projected out of the front end, are sucked or drawn through, and then thrown out of the stack. Now, it seems as though some

master mechanics have been going backward a little bit to the old idea of projecting the sparks out. They have gone back to lower exhaust nozzles, and shortening up the front end. In the words of the congressman from Georgia, I think it behooves us to look around and find out "where we are at." What do we want to accomplish? Do we want to throw the sparks out of the stack, simply throwing them out in such a condition that they will not set out fires, or do we want to keep the cinders in the front end? For freight engines you might say that it was immaterial; that if the *self-cleaning* front end was a good idea, you would not have to be bothered with cleaning out the front end at frequent intervals, and so long as the sparks did not go out in a condition to cause ignition there would be no harm done, but certainly in passenger service any master mechanic who can produce an engine that will not throw cinders, even though they may be stone cold, is accomplishing a great big thing.

There are eastern roads today that advertise on their time-tables that they use smokeless coal, anthracite, or coke. One of the prominent Boston roads is now using coke to a large extent and we fellows that cannot get anthracite and cannot get coke have got to do the next best thing. Hence, it seems to me that I rather differ from Mr. Bell's conclusions, that what we want is a self-cleaning front end. I wish some of the master mechanics in the room would feel moved to tell some of their experiences. I know of one in this room who made a very intelligent experiment with a device suggested by Mr. Von Borries of the German State Railway. As I remember that experiment it did away entirely with the baffle plate, using an exhaust nozzle which was about as high as the top row of tubes and with a straight netting across the front end. You can readily see that with that arrangement the draft in the front end was produced entirely by the suction; that there were no sparks projected at all until they got above the top row of flues. Those engines were exceedingly successful in retaining the sparks. I know of one that was in switching service that had to be cleaned out about two or three times as often as other engines of similar design provided with a baffle plate and a lower exhaust. That design certainly accomplished one of the objects that we want to accomplish, at least for passenger service; it retained the cinders and the sparks in the front end.

Mr. Hill: I saw some years ago a Western road, I do not

now know just where it was, that had the extension front of the engines equipped with steam ejectors, to blow the sparks out.

Mr. Peck : I had an engine equipped with a steam ejector and it worked nicely in warm weather, but it did not work at all in cold weather, on account of freezing up.

Mr. William Forsyth (C., B. & Q. Ry.) : The author seems to sum up the whole matter in the last sentence of the paper, where he inquires "whether or not an appliance can be produced whereby cinders may be returned to the fire box in a practically useful manner?"

That suggests to me the ideal way of arranging a draft appliance, which is one that will not throw the cinders into the smoke box at all, but will leave most of them in the fire box. That can only be accomplished by a very mild draft, and a mild draft can only be used when burning coal at a very low rate of combustion, and a low rate of combustion can only be obtained by having a large grate area. That brings us to the conclusion that the only remedy for the difficulties that we have been trying to overcome with draft appliances, is to enlarge the grate area.

Now, it is true that this is no remedy for existing engines, but it certainly suggests what should be the proper construction of the large new engines which are now being built.

The point is that with the use of larger cylinders and higher speeds, the rates of combustion must certainly increase, and with those rates of combustion increased, the intensity of the draft must be increased, and if we retain the present normal area of the grate and continue such a small ratio of grate to steam consumption, it will only repeat in the future all the trouble that we are having with small engines at present. The large engines which are being built today with moderate sized fire boxes are doing such splendid service when measured on the ton-mile basis, as compared with small engines, that very little attention is being paid to coal economy. The real measure of the efficiency of the draft appliance is, first, it should make sufficient steam, and, second, it should make it economically. I believe the only arrangement of the locomotive which will produce the maximum economy is that where the rate of combustion is kept down to 100 pounds or less, per square foot of grate.

It has been shown repeatedly in careful experiments, not only in the testing plant at Purdue, but on the road, that whenever these rates are exceeded, economy in coal burning is seriously affected.

This, then, is my suggestion in discussing this paper on draft appliances, that in considering all the troubles we have with the present engines, that a large part of it is due to small fire boxes, and that is therefore an argument for building larger fire boxes on new engines.

The President: I am told that the B., C.-R. & N. are making some experiments on single shovel firing, and I would like to ask Mr. Bushnell if any special arrangements or changes have been made to the front end of their locomotives on account of this?

Mr. Bushnell (B., C.-R. & N.): There has been no attention paid to the front end nor the question of netting. We have been using the front end as it always has been used. We have no appliance except the brick arch and the ordinary front end appliance, simply a baffle plate in front of the head cross line.

Mr. E. E. Russell Tratman (*Engineering News*): Mr. President, the grate area of the newest Illinois Central grate is longer than has been stated; it is 37½ feet long by 3½ feet wide. In regard to the Union Pacific smoke stack, I notice that the design now is very different from the old stack that they used before the straight stack was tried. They then used the old-fashioned diamond stack in which the two cones were almost alike, very much narrower and deeper than in the present stack. At the top the opening is much wider than in the old diamond stack. With this increased opening they get so much better draft that they are enabled to widen their exhaust nozzles very much. They also use a very low nozzle, which is only about six inches from the bottom of the smoke box, but then there is a draft pipe that extends up from that almost to the base of the stack.

Some of the European roads are now trying the extension front. I do not know what the inside arrangement is, but several of them put the smoke stack on the front part of the smoke box instead of the back.

As to the question of fuel, the lignite or light coal is used on the Union Pacific, and it is almost impossible to use that with the straight stack. They have had the same experience on the Canadian Pacific or divisions where they have used the same kind of coal. They tried the straight stacks on some of the engines and had to go back to the old diamond stack.

I think it would be very desirable if we could devise some way

to operate engines by which we would not have to deal with these sparks and cinders so much, but as long as we have to deal with them it is an important question what we are going to do. It is an important question on passenger trains, especially on roads that have an excursion and tourist service, as they have on the Boston & Maine, which road is now using coke fuel. According to public reports the sparks and cinders have cost them about $100,000 a year for fires alone. This they expect to save by using coke, which costs no more than the coal.

Mr. Manchester: We have with us today one of the gentlemen who was formerly in the East and was one of the good thinkers and talkers in the East, and I think the best way for him to start in, in the West, is to commence talking in the Western Railway Club. I hope we will hear from Mr. Henderson of the North-Western.

Mr. G. R. Henderson (C. & N.-W.): I do not think I deserve all the compliments that Mr. Manchester has given me and I did not know that it was one of the rules that outsiders could speak. I intend to file an application for membership and probably will work my tongue for all it is worth later on, but I think, probably, it is one of the rules that outsiders are not supposed to speak, and if that is the case, I will wait until I am no longer an outsider.

The President: It is not one of our rules. Outsiders are very welcome, and we will be glad to hear from you.

Mr. Henderson: I would like to second very strongly what Mr. Forsyth has said in regard to larger grates. I am one of, possibly, a minority who believe in large grates. Besides the good effects of reducing the rate of combustion by which we are enabled to gain an increased efficiency of fuel, both by lower rate of combustion and also by smaller loss through the stack of unburned fuel, I think the large grate is very useful in giving you a much greater range in working your fire. Of course if your grate is too large it is a very simple matter, as many have done, to reduce it, but I think nowadays it is almost impossible to get too large a grate, and, as some of the experiments recently have shown on the Philadelphia & Reading, even the bituminous coal with the large Wootten fire box produces good results.

There is one point in the conclusions that I beg to differ from, and that is, that the front end should be of what is known as the self-clean-

ing type. I think a self-cleaning front end is probably a self-dirtying back end of the train, and any one that has traveled very much in sleeping cars in the summer time no doubt has often experienced considerable disgust on finding his pillow like a piece of coal, and what you would get rid of at the front end goes down the passenger's ears and neck and does a great deal of harm. Of course a great many do not pay much attention to passenger service, preferring the freight service, but there are others that like to make it attractive to passengers.

Then, again, the point that Mr. Slater brought out in regard to the court claims in case of protection ; it certainly is very much more logical to think they have a winning chance before an average jury, if they can show that they had attempted, at least, to the best of their ability to control and retain the hot sparks, instead of throwing them all over the country. I would like to put myself on record as being against the self-cleaning method, particularly in passenger trians. I think with the freight trains it depends on the fuel, and the condition of the country where you run. If you run through a desolate country where there is nothing but sand, it would not be damaged by throwing the fires, as would be the case in inhabited parts of the country. But in passenger service I think it is very important that every effort should be made to keep the passenger trains as clean as possible.

The President : This is certainly an interesting subject and there is, no doubt, considerable more to be said on it. Our Secretary wrote to several of our members, and among them Mr. Pattee of the Great Northern. I understand that he is here, and, if so, we will be pleased to hear from him.

Mr. Pattee : I want to say that I have not read the advance sheets of the paper and would rather be excused.

Mr. Whyte : Mr. Forsyth and Mr. Henderson advocate larger grates, claiming that large grates would prevent the throwing of cinders, on the principle that the rate of combustion per square foot of grate will be lower and there result a less "lifting" effect on the fire. There are others who are trying to produce devices which may or may not draw fewer cinders from the fire box, but will catch those cinders which are drawn through the tubes and retain such cinders ; while other designers are working on devices which will break up and extinguish the cinders before the cinders are thrown from the stack.

The efforts take three directions ; one being to reduce the number of cinders thrown from the stack by reducing the number drawn from the fire box ; another, to gain the same end by retaining the cinders in the extension; and the third, to break up the cinders and extinguish the fire in them and then throw them out. The first is the most desirable, because the light particles of coal which would form cinders are kept in the fire box, where they should be kept, and because of the possible improvement in cylinder economy by using a larger exhaust tip. Some others, more or less thoughtful individuals, are working along lines more closely allied to the suggestion of Mr. Forsyth ; but they are attempting to use other means to assist the exhaust in producing the required draft, and while the methods used may be questionable, nevertheless the end sought is entirely commendable. There are at least two roads entering Chicago which are experimenting with a device which depends for its operation upon the principle that if the current of steam up the stack is properly controlled there will be a counter current of air down the stack, and it is claimed, further, that this counter current will continue through the tubes to the fire box. It is certain that there will be a counter current down the stack, but whether the counter current continues through some of the tubes to the fire box seems unimportant, because the tubes in boilers are not put there for conduits through which cold air can reach the fire box. Also, it is not desirable, generally, to draw air into the smoke box through the stack. Another device which is being tried by a Chicago road, and which has been tried by another road with remarkable results, depends, for its proper working, upon the possibility of forcing air to the fire box through pipes of large diameter, which extend from large funnels located at either side of the smoke box to the air-tight (?) ash pan and thence through the fire bed. The representatives of these roads might tell us something about these devices.

A copy of the foregoing discussion was handed to Mr. Bell, and he has closed the discussion with the following reply :

The views expressed by the gentlemen who participated in the discussion of the paper may be summarized as :

1. Dissent from the third conclusion of the author, that the front should be of the self-cleaning type, on the ground that it is dangerous in setting out fires and dirty, this position being taken, in substance, by Mr. Manchester, Mr. Deems, Mr. Delano and Mr. Henderson.

2. That, as held by Mr. Slater, the extended smoke box is advantageous in inducing a jury in a fire damage suit to find that the railroad company was using a "modern" spark arrester, and doing all in its power to prevent fires.

3. That the only remedy for the difficulties which the various appliances heretofore presented have sought to overcome, lies in enlargement of the grate area, as presented by Mr. Forsyth, and concurred in by Mr. Henderson.

To the first of these positions it may be replied that no evidence has been presented that a properly designed self-cleaning front is any more dangerous in setting out fires than the extended front, and that while it is self-evident that a front which held all the cinders would not only be cleaner than a "self-cleaning" front, but would also be *absolutely* clean, such a front does not exist, and, so long as we continue to attempt to work an insufficiently large grate beyond its capacity, by a small exhaust nozzle, *it never will exist*. The radical defect of prohibition is that it does not prohibit, of protection that it does not protect, of the radial stay that it is not radial, and of the cinder retaining extended smoke box that it does not retain the cinders. Mr. Henderson very well states the annoyance of the sleeping car passenger, but omits to mention that, in the large majority of instances, the victim is riding behind an extended smoke box of the cinder "retaining" type. If Mr. Manchester can gather most of the sparks in a run of fifty, sixty, or seventy miles, he is certainly more fortunate than motive power officers generally are, and if the record of spark losses are to be relied upon, his narrow fire box engines will certainly pull very much more than ten to twenty bushels of unconsumed coal through the tubes in such a run. Again, neither he nor any one else who has participated in the discussion, has controverted the claim which is made in the paper, that by shortening the front, while retaining an open stack, a larger exhaust can be used. This means less back pressure, less cinders to dispose of at the front end, and substantially increased fuel economy, all of which are positive advantages, showing in the fuel record, while the claim of greater "cleanliness" in the extended smoke box is entirely an abstract one, and is not one which the average passenger will be likely to endorse.

In the second place, if the extended smoke box has no greater merit than that of being held up as "modern" and perfect practice before country juries, the sooner it gets into the scrap pile the better,

and the lawyer who has no better defense to offer, will lose his case if his opponent knows his business. All that the law requires is that the engine shall be provided with a proper spark arresting appliance, and that it shall not be in bad or imperfect condition. The use of an extended smoke box will no more help the case than painting the stack red, unless the plaintiff's attorney and the judge are both more ignorant than it is safe to assume them to be.

The only rational solution of the front end problem, in the opinion of the writer, is that which is suggested by Mr. Forsyth and seconded by Mr. Henderson, viz., such an increase of grate area as will enable the fuel to be kept in the fire box and burned, instead of being, to a large extent, pulled unconsumed through the tubes by the sharp exhaust which is required to make steam with a fire box that is too small. The necessary area and disposition of grate for free and economical steaming can only be attained with a wide fire box, the assured success and extended adoption of which on railroads in the east, with both anthracite and bituminous coal, warrants the belief that it will soon be generally accepted and approved throughout the country. Both ends of the boiler may then be made on correct mechanical principles, as there will be nothing to retain in the front end, and therefore no excuse for so expanding it as to involve the objections which are necessarily resultant on the use of an extended smoke box.

The President: There are other interesting questions that could be asked on this subject, but if there is no further discussion, a motion to adjourn is in order.

Adjourned.

Library Accessions.

The Trustees of the Library wish to acknowledge, with thanks, the following gifts to the Library, received since June 1, 1899:

Mr. L. E. McGann, Commissioner of Public Works: Mayor's Message and Thirty-third Annual Report, Department of Public Works, Chicago, 1898.

Baldwin Locomotive Works: Large illustrated album, descriptive of Philadelphia and its industries. Also, Record of Recent Construction, Nos. 13 and 14.

Mr. R. H. Soule: Record of Recent Construction, Nos. 1 to 10, cloth. Published by Baldwin Locomotive Works. Also, copy of "Locomotive Data."

Mr. John W. Cloud, Secretary: Sets of advance copies of reports of committees to M. C. B. and M. M. Conventions, 1899.

Mr. J. C. Whitridge: Sets of blue prints of Atchison, Topeka & Santa Fe simple and tandem compound locomotives.

Standard Steel Works: Catalogues on Tires and on Steel Tired Wheels.

Mr. John N. Reynolds: Proceedings of Railway Signaling Club, 1897-98.

Railroad Gazette: Commercial Relations of the U. S., 1898, 2 vols.

Mr. E. E. R. Tratman: Two illustrated pamphlets on the Heilmann Electric Locomotive.

Mr. O. M. Stimson: Modern Freight Car Estimating. By O. M. Stimson, 1897. Illustrated.

Pratt & Lambert: Notes on Varnishes and Fossil Resins. By R. Ingham Clark. Illustrated.

Mr. N. L. Litten, Secretary: Constitution, By-Laws and List of Members Western Society of Engineers, 1899.

Mr. T. L. Condron: Twelve copies back issues of Proceedings of Western Railway Club.

Mr. F. M. Whyte, Secretary: Report of New York Railroad Commissioners, 1898, 2 vols.

Annual Report of John Crerar Library, 1898.

Proceedings of Western Railway Club for 1899. Cloth.

From the Secretary: Proceedings of Railway Signaling Club, 1897-98.

Mr. W. H. Elliott: Block and Interlocking Signals. By W. H. Elliott, 1896.

Chief of Ordnance, U. S. Army: Tests of metals, 1898.

Mr. J. W. Taylor, Secretary: Proceedings American Railway Master Mechanics' Association, vol. XXXII, 1899.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

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THE regular monthly meeting of the Western Railway Club was called to order at 2 p. m., Tuesday, October 17, 1899, in the Auditorium Hotel, Chicago. President H. G. Hetzler in the chair.

Following are the names of those who registered :

Ackerlind, G. A.
Anderson, Geo. T.
Angell, F. R.
Belton, T. E.
Bischoff, G. A.
Blanchard, W. A.
Brazier, F. O.
Butler, W. W.
Chase, F. A.
Coburn, W. P.
Crapo, S. T.
Crosman, Walter D.
Cushing, G. W.
Dawson, E. A.
Delano, F. A.
Demarest, T. W.
Deverell, H. T.
Deems, J. F.
Dressel, Charles H.
Elliott, W. H.
Erskine, R.
Essley, E. L.
Forsyth, A.
Gilman, C. R.
Gilmore, W. L.
Goehrs, Wm. H.
Gordon, Frank Lee
Gowing, J. P.
Graham, J. A.
Hallet, Reuben
Haskell, B.
Hatswell, T. J.
Hedrick, Elias
Henry, Wm. T.
Hetzler, H. G.
Hogan, Wm. H.
Hornish, F. W.
Hubbell, Ira C.
Hyndman, F. T.
Jacoby, W. L.
James, Geo.
Jennings, D. F.
Jones, B. D.
Keeler, S.
Kerr, C. V.
Kershaw, J. A.
Kidder, S. J.
Kirby, T. B.
Lane, F. W.
Lundquist, C. J.
Luttrell, J. W.
Mabbs, J. W.
McAlpine, A. R.
McKean, M.
McMynn, J. C.
MacKenzie, John
Magraw, W. E.
Manchester, A. E.
Marshall, W. H.
Mason, G. G.
Medway, John.
Mileham, C. M.
Miller, Robert
Mills, Geo. F.
Murphy, Chris.
Noble, L. C.
Paxton, Thos.
Peck, Peter H.
Pettis, C. D.

Pickles, Wm. D.	Smith, R. D.	Wakeman, C. J.
Quayle, R.	Smith, L. L.	Wallace, W. G.
Reilly, T. S.	Stark, F. H.	Watson, J. J.
Rhodes, G. W.	Stewart, Samuel C.	Wheeler, S.
Riddell, Chas.	Sullivan, C. L.	Wickhorst, M. H.
Sanborn, John G	Swan, C. A., Jr.	Willsie, A. N.
Sawyer, Edward ..	Taylor, J. W.	Wilson, H. M.
Schroyer, C. A.	Thompson, E. B.	Woods, G. A.
Setchel, J. H.	Thurtell, B. W.	Woods, Edwin S.
Shea, R. T.	Tratman, E. E. Russell	Woods, J. L.
Smart, R. A.	Travor, W. H.	

THE PRESIDENT: The minutes of our last meeting, as published in the Proceedings, were sent to each member, and if there are no corrections they will stand approved as published. The minutes are approved.

I will ask the Secretary to read the names of new members which have been approved by the Executive Board.

The Secretary read as follows:

Jas. Mylett, C., B. & Q. R. R. shops, Burlington, Iowa.
C. S. Henry, Western Manager, N. Y. Air Brake Co., Chicago.
W. T. Henry, Representative, N. Y. Air Brake Co., Chicago.
J. W. Coneys, Trainmaster, Pennsylvania Co., Chicago.
Geo. Whiting, Scully Steel & Iron Co., Chicago.
W. L. Gilmore, M. M., L. S. & M. S. Ry., Elkhart, Ind.
M. K. Barnum, M. M., Union Pacific Ry., Omaha, Neb.
T. W. Demarest, M. M., P., C., C. & St. L. R. R., Logansport, Ind.
Wm. D. Pence, Prof. Civ. Eng., Purdue University, Lafayette, Ind.
Arthur R. Perry, Atlantic Brass Co., Chicago, Ill.
W. H. Baldwin, Lidgerwood Mfg. Co., Chicago, Ill.
M. P. Cheney, Rd. Foreman Engs., C. & W. M. Ry., Grand Rapids, Mich.
C. L. Peck, Machinist, Belt R. R., Chicago, Ill.
C. A. Swan, M. E., Hayden & Derby, Springfield, Ill.
C. G. Brittingham, Road Supervisor Locomotives, C. & A. R. R., Bloomington, Ill.

THE PRESIDENT: The next in order is new business. The Secretary will please read a communication from the New York Club, and also the report of the Executive Board.

The Secretary read as follows:

BROOKLYN, N. Y., October 3, 1899.

Mr. F. M. Whyte, Secretary, No. 225 Dearborn St., Chicago, Ill.

DEAR SIR:—I have been requested by our Executive Committee to call the attention of your Club to the address delivered before this club at its May meeting by Col. H. S. Haines, president Atlantic & Danville Railroad, and formerly presi-

dent of the American Railway Association, on the subject of getting the International Railway Congress to hold its meeting in the United States in the year 1904.

An indispensable preliminary is to have our national government extend an invitation to the congress, the next meeting of which is to be held in Paris next year. The importance of this to the railway interests, including the manufacturers of railway materials, of this country, was fully explained by Colonel Haines in his address, which you will find in our May proceedings.

At our September meeting the club, upon the recommendation of the executive committee, adopted the following resolution :

WHEREAS, Col. H. S. Haines, at our May meeting, called the attention of this club to the desirability of having the International Railway Congress hold its meeting in this country in the year 1904, and explained that a necessary preliminary step was to obtain the sanction of our national government ; and

WHEREAS, This club recognizes the importance to the railway interests of this country, of holding the proposed meeting in the United States ; therefore,

Be it resolved, That this club requests the co-operation of other clubs and other organizations of railroad men in presenting the matter to our national government through the representatives in congress.

The course which this club proposes to pursue is to use every legitimate means within its power to induce the representatives in congress from this and adjoining states, to bring the matter before congress at its coming winter session, so that the invitation may be extended through the proper government channels. If it seems wise to do so, this club will join with other clubs and associations of railway officers in sending a committee to Washington this winter.

Will you kindly advise me at your early convenience whether we may expect your co-operation in bringing this about. Yours truly,

W. W. WHEATLY,
Secretary.

THE SECRETARY : It was recommended, at the meeting of the Board of Directors held this morning, that the letter be read to the Club, and state that it is the opinion of the Board that this Club should join with all other railway organizations in recommending to congress that the necessary steps be taken to extend an invitation through the proper government channels to the International Railway Congress to hold its meeting in the United States in 1904 ; that a committee of five be appointed to carry out the wishes of this Club in joining with other like organizations.

MR. J. F. DEEMS : I move that the action of the Board be concurred in by the meeting.

Motion duly seconded, put to the house and carried.

THE PRESIDENT : This matter calls for the naming of a committee of five by the chair, and I will ask that Messrs. Willard A.

Smith, H. P. Robinson, F. A. Delano, J. H. McConnell and Prof. Wm. F. M. Goss serve on this committee.

The President: Is there any other business to be brought before the Club? If not, we will proceed to the discussion of the papers of the day, the first of which is by Dr. Arthur R. Reynolds, Commissioner of Health, Chicago, on the subject of "The Smoke Nuisance and the Abatement Thereof." This very valuable paper has been supplemented by an interesting discussion by the Chief Smoke Inspector, Mr. John C. Schubert, which, I think, can very properly be discussed in connection with Dr. Reynolds' paper. The Secretary will read the papers.

The Smoke Nuisance, and the Abatement Thereof

By Arthur R. Reynolds, M. D., Commissioner of Health, Chicago

Believing it to be not only possible but entirely practicable to burn bituminous coal in steam-producing plants without giving offense from smoke, the City Council of Chicago passed what is known as the Smoke Ordinance. Notwithstanding all efforts covering several years, there is still a great deal of offensive smoke.

I am not unmindful of the efforts put forth by the railroads and other steam-power operators, nor of the results already achieved. It has been stated without contradiction that if all smoke stacks were allowed to operate, without any check to smoke, we in Chicago would rarely see the sky, and, at noonday, we would be enveloped in the blackness of a London fog.

Let it be granted that there is less smoke in the city than there was fifteen years ago, although the amount of coal consumed and the power produced has doubled several times over in that time, a comparison of a chimney in Chicago's down-town district and the chimneys of those cities which have no smoke-preventing ordinance will demonstrate that only a small part of the chimneys are offending, and those only occasionally. Indeed, some of the largest buildings in the city have never given offense by smoke.

What is said of the chimneys of stationary plants can also be said of locomotives. We acknowledge that the railroad companies have spent large sums of money to correct this evil, and that their efforts have not proved fruitless may be seen by observing the stack of an engine as it starts with its load from the city and again when it reaches the open country.

If there are any good and valid reasons why locomotives should smoke at all, the public is entitled to know them. I do not doubt either but there is knowledge sufficient in the Western Railway Club to tell, in a succinct and scientific manner, what those reasons are, if they exist.

My idea is, too, that in dealing with this subject of abating, or more properly putting it, abolishing the smoke evil, the railroad companies should treat the public fairly and frankly. There is certainly nothing to conceal, nothing connected with the whole subject matter, that should not be openly and freely discussed. As I view it, more light on the problem means less smoke.

If the public thinks harshly of the companies and sometimes make severe criticism of the imperious way of corporations in general, it is largely because the corporations do not speak out in meeting.

The prime reason for my appearance here today is to give the railroad companies a chance to have their say, and if their say be a frank, full and scientific exposé of the question of fuel combustion by their locomotives, we can safely promise that they will stand better in the eyes of the community than ever they stood before.

I beg to suggest that the presiding officer of this club appoint a suitable committee of competent men, selected from its own members, to pass upon the whole question of fuel combustion by locomotives, and to give in their report a resumé

of what is known upon the subject, what can be done to prevent smoke, and what cannot be done, with the reasons why.

In this connection, I beg to present, in a suggestive way, some questions which seem to me to be pertinent:

1. What are the differences between the various grades of coal on the market, both as to their power-producing units and their ability to burn without smoke? At what cost can they be utilized in a smokeless manner?

2. What conditions and capacity of grate surface, compared with the boiler capacity, have been shown to produce the most perfect combustion with the ordinary grades of bituminous coal? The term perfect combustion, is used on the assumption that where it is obtained there will be no smoke.

3. What are so-called smoke-prevention devices, and what are their limitations?

4. What changes, if any, are required in the engines now in use in Chicago?

5. What sized trains, either empty or loaded, may be hauled by an engine of a given boiler capacity without making smoke?

6. Is it practicable for the railroad companies to operate trains within the city limits without taxing their engines beyond their capacity to do their work without making smoke?

7. What part does careful and scientific firing play? and is it possible to secure and retain a competent fireman?

8. Is the examination and licensing of firemen and engineers by the city necessary? Should a fireman who can not and will not fire a locomotive smokelessly be employed at all; and if he does fire his engine smokelessly, should he be rewarded for his superior skill and care?

9. Can Illinois coal be coked, and if so, what are the obstacles in the way of its adoption as a fuel for locomotives, as to increased cost of operating?

10. Is it conceded that coke is a smokeless fuel?

11. Are not some of the very inferior grades of coal used largely responsible for locomotives smoking?

12. Do all railroads running into Chicago use about the same grade of coal, or do not some use a very good quality, while others use that so poor that the most careful and intelligent stoker cannot avoid making smoke?

If these and other questions that will occur to your scientific minds could be answered, and a full statement of the whole facts concerning smokeless combustion be made with the weight and authority of this Club's endorsement, I feel sure it would furnish a rational basis for future treatment of the question by the public and by public officials. It would, in addition, open the way for a scientific solution of the question in stationary plants as well.

SANITARY REASONS FOR SMOKE ABATEMENT.

Sunlight is necessary for proper growth and development of human life. It is also antagonistic to all pernicious germ life.

Air laden with unconsumed carbon dust and gases contained in smoke, irritates the air passages, sets up inflammation and renders them susceptible to the invasion of disease-breeding germs and is unquestionably the cause of much nasal catarrh, sore throat, bronchitis and diseases of the lungs, as well as to predispose to such contagious disease as diphtheria.

These are incontrovertible facts. How important, then, for the health of a community that it have both these God-given blessings in abundance. As a public official, charged with the responsible duty of conserving at all times the public health of this great city, the smoke evil is a matter which is forced upon me, calling for my most earnest and energetic efforts to secure its speedy removal.

ECONOMIC REASONS.

But there are other reasons, equally important, why the smoke evil must be abolished, and these we may call economic reasons.

One of the largest drygoods houses in the city, a few years ago estimated its annual loss from the destruction to textile fabrics by smoke to be $150,000. Add to this, all the textile fabrics both on sale and in wear in the city, and the figures would mount up to a fabulous sum.

Anyone who has ever lived in a community free from smoke understands the increased laundry bills in a smoky atmosphere.

Whether the question be discussed upon the sordid basis of dollars and cents or upon the grounds of sanitation, good order, cleanliness and public comfort, we arrive at the same result that the smoke nuisance must be abated. As for myself, I do not despair of sometime seeing a smokeless atmosphere in Chicago. I believe also that smokeless locomotives can be operated without loss to the stockholders or to those who furnish the brain and brawn to manipulate them.

UNNECESSARY NOISES OF LOCOMOTIVES.

It has occurred to me that while the Western Railway Club is delving into the smoke question, it can at the same time, take up that of unnecessary noises. It will not be denied that both bell and whistle have their uses and are in fact indispensable adjuncts of the locomotive. But are they not abused? Is there not a great deal of needless tooting of whistles and ringing of bells upon the locomotives in use in Chicago? Do not engineers from force of habit continue to sound their whistles at crossings where the tracks have been elevated and hence no need of it at all? With the tracks all elevated and grade crossings abolished, why should an engineer need to use either bell or whistle while his train is going through the city?

It would seem that under present conditions in Chicago, engines upon the various roads in Chicago might be operated with much less noise than formerly. If this be true, should not the reform along these lines be started at once?

In calling your attention to this subject of unnecessary noises, in so far as railroads are concerned, I have done so in no complaining or querulous spirit. I take it, from the character of men who make up this organization, that you are keenly alive to all questions, the discussion of which will improve the service of your lines and make them popular with the people. In what I have said, I have meant to offer it in a spirit of helpfulness and for the ultimate good of all concerned. I want your co-operation in dealing with these matters, which, as a public official, charged with the responsible duty of conserving the public health, I am sworn to give my earnest and constant attention.

I thank you for your cordial welcome here today, and for your evident disposition to do your full share toward bringing about a speedy and satisfactory solution of the questions which means so much for the comfort and health of the people and for the city's material growth and progress.

Obstacles Preventing the Enforcement of City Ordinances Prohibiting Smoke

By John C. Schubert, Chief Smoke Inspector

As chief of the Smoke Bureau I am brought face to face with the obstacles which lie in the way of a complete enforcement of the city ordinances prohibiting smoke.

I am, therefore, interested in a discussion of the smoke problem from my standpoint. That there are many difficulties to be met with in attempting to enforce the law against violations of the smoke ordinance will, I think, be conceded. Did none exist there would be no need of this conference today, and the members of the Western Railway Club would be devoting their energies to the solution of other problems pertaining to the successful operation of their lines.

I desire in this paper to present, in as brief and succinct form as possible, some of the chief difficulties which, since the enactment of the laws prohibiting smoke, have stood in the way of enforcing them.

First among these, I would place that of careless and unscientific firing. This difficulty applies alike to all users of steam power of any kind.

Discussing, for a moment, the subject of careless firing, I desire to say that both my experience and observation have taught me that it is not always due to ignorance, but to the indifference of the men. In this day of progress in every line of human endeavor, I take it that the merest tyro in a knowledge of the use of steam power, knows that there is an economic side to the matter of firing a plant. Also, that a plant properly fired consumes less fuel, and makes less smoke, than one that is improperly fired. Hence the conclusion that careless and incompetent firemen are expensive luxuries, and for this reason should be dispensed with.

Next in importance is the character of fuel used. As Commissioner Reynolds has indicated, I believe that this whole subject of smoke prevention should be discussed with perfect frankness on both sides. It is in this spirit that I call your attention to the matter of fuel. I have repeatedly had both engineers and firemen tell me that with the most careful firing it was utterly impossible for them to avoid making smoke. Their reasons were, of course, the inferior quality of coal furnished. Now, I personally know that these men were capable and experienced. I also know that as a direct consequence of their locomotives making smoke, they were liable to be laid off, subjected to a severe reprimand at the hands of their superiors, and possibly discharged altogether; consequently they were anxious, at least, not to be caught violating the smoke ordinance. I take it, therefore, that with the policy now enforced by many of the railroad corporations of Chicago, of laying off men whose locomotives are caught smoking by the city, they will not make smoke if they can avoid it.

I present this problem with the suggestion that its solution rests entirely with the railroad companies themselves, and not with the Smoke Bureau.

Another obstacle, and one met constantly, is the character of trains handled within the city limits. I venture the assumption that you will all agree with me that a locomotive of a given boiler capacity can haul a certain sized train without making smoke. Give it additional work to do, and it cannot do it without making smoke. I am convinced that if the railroad companies will reduce the size of trains hauled through the city, use a good quality of bituminous coal, I care not from whence it comes, and enforce careful and intelligent stoking, there will be so marked an abatement of the smoke nuisance from this source as to call forth the most favorable comment from both the press and public.

Referring once more to the subject of firing, I am pleased to see that the railroad officials are themselves thoroughly alive to its importance, and using their best efforts to enforce their rules regarding the proper stoking of their engines. I hope, too, that they will not require their engineers and firemen to do the impossible; that is, to avoid making smoke with the poorest kind of coal; but with a fair quality of coal furnished, it then becomes a matter of the company enforcing its own rules in order to make a minimum amount of smoke or to prevent it altogether.

I cannot close this paper without taking occasion to express my appreciation of the uniform courtesy shown to myself and the inspectors in the discharge of our duties, and their evident willingness to aid us in enforcing the law. I thank you for the courtesy extended in inviting me to appear before your body today. Whatever I have said has been intended in a spirit of helpfulness and to the end that, with a closer co-operation of our forces, we may be able to bring about the speedy abolition of the smoke nuisance in our city.

THE PRESIDENT: It is a pleasure for me, as chairman, to welcome Dr. Reynolds and Mr. Schubert to our meeting on behalf of the Western Railway Club, and I am certain that their papers will be of very great interest to the public at large, and far-reaching in their usefulness.

I take pleasure in introducing Dr. Reynolds, who has kindly consented to review his paper.

DR. ARTHUR R. REYNOLDS (Commissioner of Health, Chicago): Mr. President, and members of the Railway Club, I take it for granted that you have all read what I had to say in my little paper. There is but little that I can add at the present time. I read this morning, much to my surprise, in one of the newspapers, that I was going to take advantage of this opportunity, and the kindness of your invitation to meet with you, to give the railroads a piece of my mind on the question of smoke. Nothing in the world could be farther from my thoughts. How the newspaper got the information I do not know; it was not from me, however. I presume that these pam-

phlets have been circulated and have been seen. On the contrary, the prime object of my being here is to endeavor to confer upon these things as reasonable men should. It is an endeavor to get away from the use of the brute force of the police power that is placed in my hands with reference to this smoke question, as applied to locomotives and railroad people.

I think there is scarcely any question in this world, if men can disabuse their minds of their own selfish interests and their own early prejudices and education, but what a conference may settle ; hence I am naturally against the use of war in all its phases. There isn't any reason, that I can see, why the railroad companies, or you practical men acting for the railroad companies in this matter, cannot handle it just as you handle other propositions and problems in your individual lines and between the various lines ? The only difference is that you are dealing with the people, while I am humbly acting in the capacity of the people in this instance. I feel that it is necessary that some free, frank statement be made with reference to smoking locomotives, as I have stated in my paper.

I think it is not necessary for me to occupy your time; I only want to urge upon you, to insist, if I may, that you take up my suggestions and make some statement upon them. I believe it to be all important, to be quite vital, indeed, that you do so ; vital for the railway companies and vital for the people of the city.

The President : I now have pleasure in introducing Mr. J. C. Schubert.

Mr. John C. Schubert (Chief Smoke Inspector) : At the present time I do not know that I can add anything to what has been stated in the paper here. You, in the railroad business, noticed two or three months ago that war was opened by one of our papers on locomotives making dense smoke. From that it would appear as if the city was not doing anything. Now, the city has only one way of getting at the railroads when they make smoke, unless the railroads will agree to do something as has been talked of hitherto. The only thing that we can do is simply to take the railroads into court. Dr. Reynolds has told you that that is not the stand the city desires to take ; we believe this question can be settled so it will not be necessary to keep on annoying the railroad companies by bringing suit, and, at the same time, so that the public will feel that some effort is being made to correct the nuisance.

I believe we all agree on the proposition that we can get along without making so much smoke; the question is, "How can it be done?" and "Will the railroads entering the City of Chicago relieve the city from resorting to extreme measures?" As the doctor said, you gentlemen are all practical railroad men, and know more about this matter than I do. I have only had a slight experience with railroads, that is, going out on lines and watching to see what the engines were doing, as far as smoke is concerned. I remember going on one particular line, and I was astonished to see how the engine was fired. Shortly after the firing there would be five or six puffs of smoke and then no more; that was done by careful firing. I went on another line, where the fireman took an entirely different method; he would put in six or seven shovels full of coal, and there was a great deal of black smoke. I believe if all the railroads insisted on one method of firing it would lead to good results. Of course, I think the matter of fuel ought to be considered also. I will be glad to answer any question that may arise as to the administration of the ordinance.

THE PRESIDENT: This is certainly an interesting subject, and I hope the time will be thoroughly occupied, and that it will not be necessary to solicit discussion. The question is now in your hands.

MR. F. A. DELANO (C., B. & Q. R. R.): I note with a great deal of interest the attitude taken by Commissioner Reynolds and Mr. Schubert on this question, and I really believe that their attitude is a proper and sound one, because it seems to me that the interests of the railroads and of the public in this question are identical. I feel very certain that the economical and thorough combustion of coal (something we are all striving for) means the combustion of coal without smoke. Therefore, I would be very sorry to let the impression get abroad that there was indifference or opposition on the part of the railroads to accomplishing what the smoke inspector desires.

I do not believe there is any problem in locomotive engineering that is more difficult than the problem, the ever-present problem, of the economical and complete combustion of coal without smoke. The difficulties in the way are extraordinary. I might touch on some of them.

In the first place, we are trying to develop out of a boiler, the dimensions of which are cramped within definite lines, a horse power which nobody would attempt to obtain from a stationary boiler—a horse

power of, say, all the way from five to ten times what anybody would attempt to obtain from a stationary boiler.

Until very recently it seemed that we were absolutely confined in our possibilities for grate area. The size of the fire box was necessarily not wider than the frame of the engine ; the fire box had to be placed between the driving wheels, which meant that it could not be to exceed 3 feet 4 inches wide, and we naturally could not get more than something like 9 or 10 feet in length. However, an important step in the way of improvement, or looking toward an improvement, has been made by some eastern roads in the development of the idea of Mr. Wooten, formerly of the Philadelphia & Reading Ry. Mr. Wooten designed a fire box, extremely wide and shallow, for the burning of anthracite or bituminous screenings. That fire box, as originally designed, was tried in the west, but did not meet with very much favor among the users of the poor grades of western coal ; but it has been considerably improved in recent years, and I know of a number of western roads which are expecting to accomplish great results by using it. By this style of construction the fire box can be made, instead of 3 feet 4 inches wide, 6 or 8 feet wide, and you can readily see that with this increased grate area the combustion need not be so rapid, and can be made more perfect.

The road with which I am connected at the present time, has begun to build four switching engines with wide, deep fire boxes, with the hope of making a decided improvement in this matter of the thorough combustion of coal and the elimination of smoke. Here is an expenditure of something like $40,000 simply to attain these results, and I simply cite that as a case of which I am cognizant, realizing that there are a good many other similar experiments. I think the railroads appreciate that, if they could make an engine that would not make dense smoke, they would be making a wonderful step in advance.

We realize the competition of those roads which are able to advertise that they burn anthracite or smokeless coals ; we realize the possibilities of the use of coke, which has already been begun by one of the prominent roads near Boston, and it has simply been a question of cost which has prevented the use of either of these fuels in the west. It is a practical truism that a railroad must use the coal along its line ; the cost of transportation practically necessitates that. If a road has no coal along its line, it has to use the coal which it

can get with the shortest haul, and must adapt its construction to the economical use of that kind of coal.

One of the prominent locomotive works in the east has thrown out the challenge that, if a railroad company will send to them the analysis of the coal they have to use, the locomotive works will design and build a locomotive for its economical consumption; and by "economical consumption" I mean consumption without smoke.

Mr. Schubert has touched very properly on the point of firing. The best construction in the world cannot do it all. Even in stationary plants, where the facilities for having perfect combustion are much greater than on any locomotive, we know that the boilers, carelessly fired, will emit a great deal of smoke. We also know that a locomotive skillfully fired is wonderfully free from smoke, even if the design is not specially good. But, much as our railroads would like to have that kind of firemen, they are a rather scarce article, I am sorry to say. Among firemen and locomotive engineers, just as in any other profession, there are men who are artists at their trade, and there are men who are just common, ordinary, work-a-day men. If we could have all our firemen artists, we would like it very much; but if we limited the employment of men to men who are artists in that trade, we would have to go without firemen, and we would have to do as we do now—do the next best thing, hire the best we can.

I notice the commissioner suggests that the chairman appoint a committee from this Club to investigate this subject further. Although I feel that this is a subject that is always before us, never absent, I would move you, sir, that we adopt the suggestion of the Commissioner, and that the president of this Club appoint a committee to investigate this subject and report at some subsequent meeting what is now being done along this line of smoke prevention, and what lines we should work on to accomplish the results sought after.

Motion duly seconded, and the question declared open for discussion.

Mr. Robert Quayle (C. & N.W. Ry.): Mr. President, I have read both these papers; the one by the Commissioner of Health and the other by the Chief Smoke Inspector, with a good deal of interest, and I think it is fair to say that if this is a frank and open expression of how they feel toward the railroads, we have no criticism to offer except that which is favorable. On page 13 of this paper the first question asked is:

1. "What are the differences between the various grades of coal on the market, both as to their power-producing units and their ability to burn without smoke? At what cost can they be utilized in a smokeless manner?"

I think most of the roads situated in Chicago have to burn a greater variety of coal than the railroads do at other points; sometimes because coal is very hard to get. I think that is true, at this very time; that we in Chicago have to burn what we can get. Some coals are rich in hydro-carbons and some lower. Some coals throw off the gases at a very much lower temperature than other coals, and it is necessary for us to have considerable oxygen to produce combustion, and the coals that throw off the gases at a low temperature we find often do not get sufficient heat to consume the gases in the fire box, and consequently they pass off unconsumed. I do not know how railroad companies are going to avoid that, unless we can fix conditions to fit the kind of coal we are obliged to use.

2. "What conditions and capacity of grate service, compared with the boiler capacity, have been shown to produce the most perfect combustion with the ordinary grades of bituminous coal?" The term "perfect combustion" is used on the assumption that where it is obtained there will be no smoke.

I do not know just exactly how to answer that question, but I might say in this connection that a number of the engines that are in service today, perhaps not in Chicago, but on various roads outside of Chicago, were built a number of years ago. They are suitable for certain service, but so far as the road with which I am connected is concerned, within the last few years we have put into this city engines with large grate area and large heating surface, so that they are able to produce steam quickly and easily, so that the firemen might not have to fire as heavily as they would have to do under other or less favorable conditions.

3. "What are so-called smoke prevention devices, and what are their limitations?"

We have used various devices for the prevention of smoke: Air jets, steam jets, and by putting tubes into the fire box at different places, to allow a sufficient quantity of air to pass in over the top of the fire, and have endeavored at the same time not to allow too much air to pass in so as to reduce the temperature of the fire box; and we have also tried to educate the firemen, which, as is well stated in one

of these papers, is one of the most important features. Five years ago I issued a circular that was put into the hands of every engineer and fireman on the North-Western system, to the effect that a man must put in his coal at frequent intervals. I said that, like a ward politician voting, he must do it early and often ; he must not put in five or six shovels full of coal and then get up on his seat, and sit there and look at the volume of black smoke ; and I also said that if he did that he would surely find his record pretty well down toward the bottom of the list.

We are interested in this subject because the coal bill is one of the principal items of expense—wages highest, fuel next—and if we can save 5, 2, or less, per cent. of that, we are saving a considerable amount, and for that reason we endeavor, just as much and as hard as we can, to prevent the black smoke nuisance ; we also try not to be a nuisance to those who ride on our trains and the citizens of the different towns and cities through which we pass.

We find, however, as Mr. Delano says, it is quite difficult, often, to get these men to fall in line, and sometimes it comes to our attention that when they get outside of the city limits they are not nearly so careful as they are inside. You can easily see if a man puts five or six shovels full of coal into the box that the coal at once lowers the temperature in the degree that it absorbs the heat, gas is thrown off and there isn't enough heat to prevent bad results.

Question No. 5 cannot readily be answered from the question alone ; if a given sized engine were mentioned, I could answer with some degree of accuracy.

"Is it practicable for the railroad companies to operate trains within the city limits without taxing their engines beyond their capacity to do their work without making smoke ?"

I think that so far as freight trains and, usually, passenger trains are concerned, that it is, and I think it is being done, but if you are switching a string of cars through the city, and it is suddenly stopped as the fireman has just put in, say, two or three shovels full of coal, and the engineer shuts off suddenly, the black smoke will roll out, it can't be helped ; the inspector will catch the man just at that time, and he is reported. I think we have no fireman on the road, no matter how artistic he may be, who can prevent that.

As far as the examination and licensing of firemen and engineers by the city is concerned, I would say no to that, as far as the Chicago

& North-Western railroad is concerned. I think we give our men a pretty rigid examination, and I think it is entirely unnecessary for them to go before the necessary city authorities to take an examination, although I have no objection personally.

9. "Can Illinois coal be coked, and if so, what are the obstacles in the way of its adoption, as a fuel for locomotives, as to increased cost of operating?"

I understand Illinois coal, as a rule, cannot be coked. I think it is generally conceded by the experiments recently made on the Boston & Maine, that coke is a smokeless fuel. They obtain it there as a by product, and they get it cheaper than coal. Of course, if we could do that, it would be all right; but if we had to coke our coal, it would cost a little more, and it might be thought necessary to do that in cases where we are not able to prevent smoke in any other way.

11. "Are not some of the very inferior grades of coal used, largely responsible for locomotives smoking?"

I think not. I think that some of the coals that we pay the highest price for, which are richest, perhaps, in gases, will give us just as much trouble. I had an experience recently with some coal that we purchased, that was much higher priced than the coal we are now getting. It was a rich coal, but, as I said in the beginning, it slacked so quickly with a very low heat, and gave off its gases so quickly, that the black smoke rolled right out. It was not ordinary brown smoke, but just as black as could be. We found fault with our men for the manner in which they were using it, and they said, "Try it yourself," and we had some men put on who tried it, and they failed to use it without making very much smoke.

So far as the twelfth question is concerned, I cannot answer that properly. I suppose they use different degrees of coal at different values. I think, however, Mr. Chairman and gentlemen, that the railroad companies ought to do everything in their power to assist the city authorities to eliminate just as much of this black smoke as we can; to get our engines in such condition and educate our men in such manner as will bring about the very best results; and I will say, so far as our company is concerned, we are very anxious to do everything we can; and I think the officers of the City Health Department, in every instance that we have had anything to do with them, have been considerate of our interests. When matters have

been explained to them, they have always listened attentively and kindly given us the consideration we should expect from man to man.

Mr. W. H. Marshall (L. S. & M. S. Ry.): Mr. Chairman and gentlemen: I feel that, while the question of the economical combustion of fuel is always with us, and the railroads are endeavoring to improve their practices pertaining to a better combustion of coal, a committee such as is suggested to be appointed by this body might do valuable work. I think that if such a committee goes into the question thoroughly, and presents to us a standard of excellence to which we can work, it will do very much to clear up the whole situation.

I believe, if this committee does its work properly, it will endeavor to find out the best results that can be obtained with present equipment and, as much as possible, with present fuels. Railroad companies must consider the cost of the service which they render; and while they willingly do all they can to reduce the smoke nuisance, it certainly would not be in line to ask them to change the proportions of all the engines in Chicago, or to remove them and put others in their place, or to change the grade of the fuel used and substitute a very much more expensive grade, unless it is first demonstrated that those steps are actually necessary in order to obtain the results.

As has been said, every railroad has engines that are not modern, and it follows that they must use them. They are also limited frequently as to the quality of fuel they can use. I think a good many of us today are using fuel right here in Chicago that we do not want to use. I know that is the case with the company with which I am connected. I believe there is very much that can be done in improving the work of our firemen, and that much more can be accomplished in this direction than in changing the construction of the locomotives, although in some cases a better proportioned engine will undoubtedly reduce the production of smoke.

Mr. Robert Miller (Michigan Central R. R.): I think what the Commissioner wants to know is what we are doing and what we are willing to do.

So far as the road I am connected with is concerned, we use a system of steam jets, brick arches, and we have given our firemen instructions, placed books in their hands, and tried to enforce a compliance with the ordinance. I do not believe that we have always been successful. I have noticed on trains, where the fireman knew I

was on the train, that he succeeded in firing with very little smoke; then, again, I might meet another train somewhere on the road, and I would find that they were not living up to instructions. I do not know how we can reach that trouble in any way, except by discipline, and that is a long road. I believe, however, that this matter of combustion and smokeless firing has been agitated so much of late that there is an improvement on our road since I took the question up.

There are a good many conditions with which, I think, all mechanics will agree with me. You may adjust an engine with proper grates, different kinds of grates, that will be just right for a certain class of coal. For some reason, either a strike in the mines or something else, you are unable to get that class of coal, and the result is you do not get as good results from your fire. I have always taken the position with our fuel agent that if he would buy one grade of coal, and let me adjust the locomotives to that, and then burn that class of coal and no other, I could get better results; but that is not practical, as we have to use what we can get at times.

Now, as to what this Club is willing to do—I think I can say, without fear of contradiction, that it is willing to co-operate with the Commissioner and his assistant, in every way, to bring about better results. I certainly would be glad to do so. I have just recently issued a circular to firemen, especially in the Chicago district, stating that, unless they did pay attention to the instructions that had been given them, I should certainly dispense with their services. I think that careful firing will go as far as any other thing we can do to bring about the desired result.

Professor R. A. Smart (Purdue University): Mr. Chairman, there can be no doubt, it seems to me, that there is a wide difference between the ordinary practice of road firing on most railroads in this or any other section of the country, and the best that can be done on that road, both as to the quality of the coal used and as to the manner of firing; and if that be true, it follows that most of the roads can do something in the way of improving the combustion of coal, and thereby diminishing, to some extent at least, the production of smoke. We must, however, recognize that there is a difference between the operation of locomotives on the road and the operation of locomotives at or near terminals, and it hardly need be said that the operating of locomotives near terminals involves conditions much less favorable to the proper and smokeless combustion of fuel than

those which obtain on the road. From my experience in testing locomotives, and from what I have been able to observe on the road, I am led to believe that even with the best coal that is obtainable, and the best and most skillful firing, it would be almost impossible to do away absolutely with the production of smoke in locomotives operating near terminals, especially those pulling out from terminals. At least, I feel confident in saying that the difficulties in the way of the reduction of smoke are very much more serious. It is evident to all those who are familiar with locomotive service that where your conditions are variable your fire can not be maintained in an even condition, and, therefore, your manner of firing can not be a constant one and the one which will produce the best results.

Allusion has already been made to the fact that trains must sometimes be stopped unexpectedly. The fire may not be in condition to allow the locomotive to stop ; there must be slow-downs and accelerations, which make it almost impossible to produce smokeless results in firing, even with the best coal and the most careful attention. So it seems to me that it should be taken into account that the problem is much more serious than that which confronts the railroad men on the road, or than that which confronts the operator of a stationary plant, whose conditions of operation are more nearly constant, and hence favorable to smokeless combustion.

Mr. P. H. Peck (C. & W. I. R. R.) : A great trouble in many of our passenger switching yards and depots in this city is that many of the yards are too small, especially during some parts of the day when suburban traffic is heavy. We have to take the trains in and out of the train shed very quickly, and in doing so the engines cannot be handled with a light fire on account of spoiling the fire in starting, and then the engine would not steam with a fire light enough to do the work quickly. The moment you shut off the engine there is a black smoke. In places where we have a continuous run we can avoid the smoke very much by careful firing, but in such cases, if the engine be suddenly shut off by being flagged, or not getting block signal or a semaphore, smoke will be made, and it must go somewhere, and that place is out of the stack. I think by careful firing, and the engineer and fireman working in harmony, they can almost entirely avoid making smoke enough to violate the city ordinance.

I have tried a great many smoke devices, about ten during the last ten years in Chicago, but I found they were all failures to a cer-

tain extent; they were all built on the same principle, namely, to let cold air into the fire box above the fire. Another thing—I found them expensive in the consumption of fuel. They operated on the same principle as running an engine with fire box door open, and we all know in such cases we do not get much steam, and at the same time lose lots of fuel.

I remember, fourteen or fifteen years ago, there was a return flue boiler in use out of this city. The stack was placed just in front of the cab and back end of the boiler, but it only run a short time and was a failure.

We have lost considerable money in smoke devices and, in fact, have all our engines equipped with some kind of a smoke burning device at present.

I understand there is a new device coming out, and the claim is made that it will burn all the smoke. If this is a fact, we would gladly adopt it.

I think the course now pursued by Dr. Reynolds and Mr. Schubert is a wise one, and it will do more good toward abating the smoke nuisance in Chicago than anything that has been done in the past. The railroads are as anxious to do away with the smoke as the city is, and if the heads of the mechanical department of the railroads and the city health department work together in harmony it will bring out the desired result. No doubt a committee will be appointed by the Chairman, and with good work on the part of the committee, assisted by the mechanical department of the railroads, I think the probability is the smoke will be reduced 50 per cent. from what it is at the present time.

Mr. Jno. C. McMynn (Robert W. Hunt & Co.): Mr. President: I am sure that all of us appreciate, both as citizens and as railroad men, the desirability of abolishing to as great an extent as possible the "smoke nuisance," although we must admit that cheap fuel has been a most potent factor in the development of our city and the industries located contiguous to Chicago.

There has been a great deal done successfully in the direction of preventing smoke in stationary boilers, and, as far as my observations go, a saving has resulted in every case where smoke has been prevented by scientific processes, i. e., by causing complete combustion to occur before allowing the volatile gases to come in contact with the comparatively cold walls and flues of the boiler proper. How-

ever, in the case of a locomotive boiler, the problem is a much more difficult one, and must be solved by a different method. In a stationary plant, sufficient grate area can be provided to reduce the amount of coal burned per square foot, to a point where the volatile gases have time to pass off slowly, and a sufficient amount of heated air can be provided in order to insure a combination of such air with the volatile gases before they are thrown in contact with the boiler. This combination causes a much higher initial temperature, and hence a greater passage of heat into the water in the boiler.

In a locomotive an entirely different set of conditions exists. The fire box is surrounded by sheets of steel, which are of a temperature about equal to that of the surrounding water, say, approximately, 350 degrees F. The volatile gases thrown off from the coal immediately come in contact with this low temperature, and smoke is formed. A maximum instead of a minimum amount of coal must be burned per unit of grate surface, and such combustion is hastened to the greatest extent possible by means of the exhaust nozzle in the stack. No time can be given to the consideration of preventing smoke, in many instances. In passenger service, with a certain number of cars in the train, a known time of starting, and fixed stops, much can be done by a fireman to stop smoke within the city limits ; but with a switching engine, when twenty or thirty more cars may be added to the train unexpectedly, and, instead of being sent over a straight track, a heavy grade and reverse curves are encountered, the steam pressure must be maintained at all events, and the maximum amount of fuel consumed without regard to economy or smoke prevention.

Cars of perishable freight and anticipated merchandise must be moved in order to meet the demands of commerce ; and I dare say that the merchants most anxious to abate smoke from locomotives would be the first to object, were a consignment of goods delayed and the reason given by the railroad that they were hauling shorter trains, in order to prevent their locomotives "throwing out volumes of dense, black smoke."

Should the plan be carried out to build a railroad clearing house outside of the city limits, on the plans laid out by Mr. Stickney, much of the congested traffic in the city would be avoided.

Referring to the Commissioner's question concerning the different kinds of coal : The coals from the western states contain much more volatile matter than the eastern bituminous coals from the Po-

cahontas or New River districts, and consequently produce more smoke. More air is required to perfect combustion; but if the fire door remains open long enough to admit the necessary cold air, the evaporation is reduced; or if a very light fire is carried, so as to admit more air through the grate, an engine is likely to become stalled.

Considering question No. 3, "What are so-called smoke prevention devices, and what are their limitations?"

The chief limitation to the application of a smoke preventing device to a locomotive is the size of the fire box. The width of the fire box, to a certain extent, is limited by the distance between the drivers, and the total length obtainable is required in order to obtain grate surface sufficient to burn the amount of coal necessary to develop the required horse power. The movement and jar of a locomotive prevents any system of arches or checker work being permanent.

Question No. 9 asks, "Can Illinois coal be coked, and, if so, what are the obstacles in the way of its adoption as a fuel for locomotives, as to increased cost of operating?"

In answering this question, I desire to first disclaim any intention of advertising a new system, but desire to simply present a few facts which I consider of highest importance from a scientific standpoint. Last fall the firm with which I am connected were retained by Mr. L. Z. Leiter to design a coking furnace in accordance with the ideas and inventions of Prof. Joseph Hemmingway, which invention referred especially to coking the poorer qualities of western coals and lignites. The first furnace was built at 40th street and Wentworth avenue, and from the very first it was evident that remarkable results could be obtained. In fact, the experiments have been more successful than were anticipated. Since then, four more furnaces have been erected, and various Illinois and Iowa coals have been treated, and the result has been an excellent quality of coke, which resembles greatly in appearance the famous Connellsville coke. The sulphur is eliminated very largely, and the fixed carbon runs high.

Coke is used as fuel on some eastern roads, and, I understand, very successfully, by mixing a certain percentage of coal with the coke. This avoids the production of smoke, and is economical in proportion to the price of the coke.

In the large Boston plant, it is commonly understood that the coke is considered the by product, while the main income is de-

rived from the ingredients that are usually known as "by products."

While the time has not come, yet I am hopeful that before very long, plants can be established on the various railroads, where the coal can be coked and the cost be defrayed by the utilization of the by products.

Since the gas companies have ceased to produce coke, due to the adoption of water gas, the supply of domestic coke has gradually been reduced, until at the present time it is practically impossible to obtain this quality of coke.

My reply to question No. 10 is that there is no question whatever that coke is practically a smokeless fuel.

Referring to question 11, "Are not some of the very inferior grades of coal used, largely responsible for locomotive smoking?"

To a certain extent they are; but a railroad could hardly be expected to pay $3 per ton for an eastern coal, when they can obtain a fuel for half that sum from nearer their own line.

Volatile matter contains valuable heating capacity, if properly burned in a smoke preventing furnace, but a coal that will give the most economical results in a stationary plant, may give very poor results in a locomotive. An inferior grade of coal can be mixed with coke in proper proportions, and a smokeless, as well as an economical, fuel be obtained.

Mr. T. S. Reilly (*Railway and Engineering Review*): It would seem that for smokeless locomotive service the question of a constant fuel is vital. If we could always get one grade of fuel, we could adjust the grate area, the heating surface, etc., to the conditions necessary to burn that fuel. This latter can be readily done in stationary practice, but in locomotive practice it cannot, because the service is intermittent. In cities, switching and suburban engines have to stop and start at all times, so that the conditions under which the coal is being burned are constantly varying, much to the detriment of the process. And where the coal varies in character or grade, these conditions are additionally complicated. I believe Mr. Delano has stated that the Wooten boiler has been tried with bituminous coal, but, as I understand it, more particularly in burning slack. For block coal a Wooten boiler has a grate area too large, while for slack coal the grate area is too small in the ordinary boiler. Bituminous coal is a longer flaming coal than anthracite, and it seems to me that in adopt-

ing the Wooten boiler for bituminous coal burning it will be necessary to subject its design to considerable modification.

The Philadelphia & Reading tried some bituminous coal burning with a Wooten boiler, and they found a very intense heat in the front end, showing that this flame length was too long in that boiler, indicating that its proportions should be altered. However, this question will undoubtedly be gone into by the committee.

Now, as regards slack and block bituminous coal, and the utility of different grades of coal. The slack coal is often spoken of as an inferior grade of coal. The slack coal is just as rich as block coal; it contains the same constituents, but its use necessitates a different area of grate, and a different method of firing; while slack coal is very much cheaper, the difference in price mounts up very fast. For instance, in a stationary test, Illinois slack coal, costing $1.40, evaporated 8.5 pounds of water per pound of coal, which would give a cost of 8.3 cents per 1,000 pounds of water evaporated. The best anthracite, costing $4.80 per ton, would evaporate no more than 12 pounds of water per pound of coal, which would result in a cost of 20 cents per 1,000 pounds of water evaporated. If we substitute $1.50 a ton coal for $4.00 a ton coal, the former will only have to evaporate .38 as much water in order to justify its substitution, and as it gives a much greater proportional evaporation than this, these figures show that it is worth while to use a slack coal.

If it could be made possible to obtain a coal the grade and character of which would never vary, I believe we could design a boiler to burn that coal without an excessive amount of smoke, but with a constantly varying character of fuel it is practically impossible to so perfectly control the combustive conditions that no smoke will be evolved. Of course, I think it must be understood that a working engine, in any service, will be bound to give off a certain amount of smoke at times, but in steady service with the conditions outlined, locomotives could be so arranged that there will be very little or no smoke.

Dr. Reynolds: Mr. Chairman, and gentlemen, I feel very much gratified indeed at the reception our papers have had, and the courteous things that have been said about Mr. Schubert's administration of the Smoke Bureau, and I believe that practically all of our questions have been answered here in this discussion.

I have heard a great many things here today that I did not know before. They are old already to you, perhaps, but are new to me.

These are questions that the great mass of the public know nothing at all about, so it is necessary that things be said and resaid and said over again, and that is one of the reasons why I wanted some expression from this body ; it will furnish the best line or guide of conduct in our treatment of locomotives that smoke. If we have these condensed expressions made to the point, and can use them in our dealings with railroad companies, or engineers or master mechanics, it will probably serve the very purpose that a suit at law serves, and be so much more decent and humane.

We have always recognized that the smoke made by the sudden stopping and starting of engines and heavy grades cannot be overcome, and we have never, to my knowledge, brought suits against engines being used in that way.

One little point about old engines. It never occurred to me that some engines built long ago have not the modern appliances, and, of course, are perhaps more inclined to smoke. We, of course, must consider the question of dollars and cents in this thing. Those old engines are valuable. Perhaps they might be shifted out on to the prairies.

I hope, indeed, that this motion to appoint this committee will prevail, Mr. Chairman, and I hope further that the committee will go to work at once and do something, and if there is anything that I can do, any influence from the city government that you need in connection with making that report that I can bring about, I will be most happy to be at your service. I sincerely thank you for the courtesy extended today.

Mr. Schubert : Mr. Chairman, and gentlemen, I do not know that I have much to add to what the doctor has already said, excepting this, that while from this discussion I am satisfied that the railroads do take up this matter and reprimand their men when their engines smoke, still, from the arguments advanced by the gentleman who said he was making scientific experiments with coking Illinois coal, firemen claim they smoke because of poor coal and because they are not allowed to keep the fire box door open. I am satisfied of the truth of this statement.

I hope this committee will take up the question and see whether it will not be the safest and wisest thing for these companies to help their men to fire carefully. For instance, the railroads might allow their men the privilege of having their fire box door open slightly, even

though it would cost the railroads about 30 per cent. more fuel, as was suggested by one of the speakers. It is true that it will cost a little more coal, but I believe it will do very much toward keeping down the smoke, as much so as careful firing. Men come to me and they say, "Another thing; if I am permitted to use a sufficient amount of coal to fire with, I think I can do a great deal better." Now I know of one road which, a short time ago, offered a premium to its men for saving fuel, and, of course, that meant that the firemen would not keep their fire box open, even slightly. It seems to be agreed that a little bit of air let in through the fire box will do away with considerable smoke. I hope this committee will settle on something in respect to that point. I am satisfied that if the men are instructed to fire carefully, and are allowed to use the proper amount of fuel, that we will have much less smoke, and you will have less complaints than you have now. It is a fact—for instance, take Mr. Quayle's road—some time ago there was fault found with the engines running on Kinzie street, under the viaduct ; communication was had with the North-Western road and I am pleased to say that there are but few complaints being made since that time. If they can improve matters there, there is no reason why they cannot do it somewhere else. If the men are instructed to be as careful elsewhere as they are along Kinzie street, I believe we can do away with a great deal of the smoke.

Now, I don't believe that any citizen will complain of a few puffs of smoke. I believe the people are just as liberal as the law is, and the law certainly is not a harsh one ; it provides only against dense smoke. We all know that where we use soft coal there must be some smoke, but we must try to do the best we can, and perhaps when these experiments are completed in making coke, the coke won't cost any more than coal does now. Some one has spoken here of the changes made in the locomotives at Boston. I have been told that they have 100 locomotives ; that they are making a very few small changes in their machinery, and they say it does not cost one cent more for coke than for coal, and that it is a solution of the dirt and smoke problem. It is to be hoped that before long we shall have these coking stations, but until that time does come, I think, with proper care, we can have a great deal less smoke than we are now having in Chicago.

The motion of Mr. Delano was put to the house by the President, and carried.

The President named the following gentlemen as the committee called for by the motion already passed: G. R. Henderson, Prof. R. A. Smart, Mr. J. C. McMynn, R. D. Smith and J. W. Luttrell.

Mr. G. W. Rhodes (B. & M. R. R. R.): There is much gained in having a meeting like this, and talking over the different devices and the difficulties in the way of accomplishing what we all want. I would offer as a suggestion to the committee that during its deliberations it endeavor to have the city represented; in this way there will be a better understanding all through, as to the difficulties in the way of accomplishing the end which we are all after. I do not believe it will be necessary to have one or more of the city representatives on the committee, as I hear some one suggest, but I would recommend the committee to call in the city officials and advise with them.

The President: If there is nothing more to be said on this subject, the discussion of the topical subject, "What would be the advantage to railroads in adopting a box car of typical inside dimensions?" is in order. Mr. Rhodes has very kindly consented to open this discussion.

Mr. G. W. Rhodes (B. & M. R. R. R.): Mr. Chairman, and gentlemen, I have undertaken this afternoon to open the discussion on what would be the advantages and the practicability of a typical box car.

Some short time ago I was, to my distress, asked to serve on a committee having in view the establishment of a standard box car. I think that anybody who has been connected with the Master Car Builders' Association and the Master Mechanics' Association will know at once how hopeless I felt as to being able to bring out anything in the line of a standard box car, but there have been a good many other apparently impracticable and hopeless questions brought up before the railroads, and if the members will have a little patience, and will do a little work, at the end of some time, not any quick time, some results may be brought about, as they have been in other matters. For instance, I do not know of any more hopeless sort of a question than that of establishing a standard coupler for cars in this country as it struck many of us ten, twelve, thirteen years ago. See what the results of it are today. I do not know a very much more hopeless question than that of establishing a standard brake in this country as it was in 1886 and 1887. All kinds of different power brakes were being introduced at that time, and yet, what is the result today? We

have a type of automatic brake regarded everywhere as standard, and other devices, into which large sums of money were invested, are wiped out and heard of no more.

When I first met with some of the American Railway Association's committee on a standard box car, I was surprised at their hopefulness as to the end, and also I was surprised that they did not expect to accomplish anything immediately, and talked of two or three years to bring about results.

Our committee has already had two or three meetings. We issued a circular asking for information about the dimensions of box cars. The answers that came in, at first sight, one might say, were not very satisfactory. The committee proposed a typical car, giving figures, and 81 roads, representing 348,708 cars, reported in favor of the committee's proposed standards. Fifty-seven roads, representing 482,968 cars, reported unfavorably on the committee's proposed standard, but a curious thing showed up in the reports of the 57 roads that reported unfavorably; they, at the committee's request, made their own recommendations, and they reported forty or fifty different kinds of cars which varied, perhaps, one inch or two or three inches in interior dimensions. This is the hopeful side, to the committee. We felt that there was a little misunderstanding on the part of the railroads as to the scope of the committee's work and the intention of the committee's work, and our committee believed if we could, in some way, get this question before the mechanical men who have the designing of the cars, and get them to co-operate with their operating officers, that we might easily reconcile these differences and come to a standard car.

I might say in this connection, that one of the reasons that has been advanced for having correct typical dimensions has been from a constructor's standpoint. The manager of a large system states that in going into the iron and steel cars, as we are now doing, it would be a great advantage, in getting supplies, if we could have the parts which make up these steel cars and these iron cars, of standard dimensions, so that they will be a commercial article. That is one point from the constructor's standpoint. We have not found any difficulty in adapting the standard axle to our freight cars of 100,000-pound capacity as well as to cars of 80,000-pound capacity. I believe there are very few railroads building 100,000-pound cars that

will undertake to use a different axle than that adopted by the Master Car Builders' Association.

This is also the case in certain details in the running gear of our cars, which are interchangeable all through the country. It would seem to be quite practicable, also, for some of the other important parts, such as sills, posts and other parts of the car, to be made standard.

To show a little of what has been done in this matter, I will state that the committee, in starting out, did not propose to define just how long the car shall be, just how high it should be, etc., or just how wide it should be. It confined itself to proposing interior dimensions. I believe it goes without saying that the most economical box car a railroad company can build is one that has the greatest width allowable on the lines of the railroad company that is building the car, and next is the one that has the greatest height allowable on the lines of the railroad company building the car. Now, the committee has endeavored to get for the railroads these figures, and the outline that they propose is this : All the figures used by the committee are inside dimensions.

The proposed inside height, from the top of the floor to the bottom of the carlin immediately over the plates, is 8 feet ; the proposed width between linings is 8 feet 6 inches ; the proposed length between linings is 34 feet. This gives a car with contents of 2,312 cubic feet, and per foot, 68 cubic feet.

To show how near these figures are to the equipment of a western road, for instance, the C., B. & Q., I will cite the following : The proposed height is 8 feet ; the C., B. & Q. standard is 7 feet 5 inches. Personally, I do not know of any reason why the C., B. & Q. could not make its cars 7 inches higher, and thereby comply with the typical car. The width proposed is 8 feet 6 inches, between linings ; the C., B. & Q. is 8 feet 2 inches. I believe, without any material change in our standards, we could make the necessary additional width. The length inside of the C., B. & Q. cars is 33 feet 5 inches, whereas the length of the proposed car is 34 feet.

On some of the lines east, as soon as these figures were proposed, or talked about, and some arguments made from the utility standpoint as to why they should be used, one of the lines, the New York Central, said they thought they could change their standards so as to comply with the proposed typical car. The General Manager of the

Atchison road had a number of cars to contract for, and he told the committee, at our last meeting, that he had instructed that the interior dimensions conform to the proposed typical car.

The Pennsylvania railroad has this matter now under serious consideration. The committee has asked whether, on account of changes they are now making in their tunnels, the typical dimensions might not become practicable, perhaps, in a year or a year and a half from now.

To show how much serious attention has been given to this, I refer you to the proceedings of the American Railway Association, held at the Holland House, New York, in October, 1897. In this report you will find a voluminous correspondence from the different traffic associations, in regard to investigations that they have made looking toward stopping the variations in cars, from small cars to very big cars, and the difficulties the traffic departments are getting into in connection with such great variations in car dimensions. A report in connection with these very matters is signed by the following mechanical gentlemen, whom most of you know, Mr. William Buchanan being chairman of the committee that made the report: F. D. Casanave, E. W. Grieves, E. D. Bronner, J. N. Barr, F. Rearden, Jno. Hickey and Jno. W. Cloud.

In another communication, Mr. Commissioner Blanchard makes a report in which seven different proposals were considered, and Mr. Blanchard goes over these seven different proposals very carefully, showing that none of them were practical, in his estimation. Now, the question comes up here as to why it might not be possible for the lines in the east and the lines in the west to agree upon a typical car. In the first place, the lines in the east, many of them, have double track roads. Out in the west we are getting into the same condition. All the roads with single tracks have their yards, and they are limited in their distances from center to center, and we ought to use cars as wide as is safe to do and pass over our center to center distance.

On the roads west, if my information is correct, the distance between centers has usually been considered 14 feet, whereas, in the east it is about 12 feet. That was the way it was in olden times, when we did not work things quite as closely as we do now. At the present time the Burlington road has changed its standard double track road from 14-feet centers to 13-feet centers. It realizes that 13 feet is plenty wide enough for all conditions of service, and that

the economy is great in constructing double track with 13-feet centers in place of 14. Bridge abutments, piers, embankments, cuts, bridges, etc., all largely enter into the cost of construction, and, if made wider than necessary, add to the expense without adequate return. The lines in the west are beginning to find that what is good practice for the lines in the east is good practice for the lines in the west, and it seems to me we ought to be able to agree on some typical car dimensions.

As a matter of fact, a typical car has always existed in the minds of traffic men, and has been used in fixing minimum rates. Somebody elects to determine what a typical car is. It is, perhaps, somebody who is not very well informed in the construction of the car, and under one regime he selects a small car, and that puts a premium on small cars. Some other committee, succeeding the one selecting a small car, makes its typical car a very big car, that throws out of service the small car. That has been going on for a long time, so that this question of a typical car is not a new one. In fixing minimum rates, some form of typical car has to be used. The present object is to get a typical car built which will be regarded as the most economical and cheapest car for all railroads to operate. It is hoped that, by getting the mechanical men interested in this very important question, its solution will not be so far away as may at first appear.

Mr. S. T. Crapo (F. & P. M. R. R.) : Mr. President, I have had to consider this question of the typical car as relating to the shipper.

There has been a good deal said lately about the Vanderbilts. There was a time when the Commodore was getting into the start of his great future influence, when one of his sons came to him and asked him for a load of manure. The Commodore said, "All right." He thought the boy wanted a wagon-load of manure, but the boy got the biggest scow he could and got all the old man's manure.

Now, in the railroad world, with which the Vanderbilts have had a great deal to do, there is a unit of measure which has pretty nearly as large a variance as there was in the loads those people dealt with at that time. You talk about carloads, the traffic men talk about carloads; the revenues of our railroads are based either on carload rates, which are given at great discount, or on less than carload rates which are higher. The fact is, men wonder what a carload is. We have all heard of the boy that in talking about cars said, "Little car, don't cry; you'll be an elevator by and by," and that is what the traffic men

are asking—is it a 28-foot car, or is it an elevator on wheels? They call them both a carload, and there is no distinction.

Now it is for you practical gentlemen to first decide what, as Mr. Loree lately put it in our meetings, is the most economical vehicle of transportation. That is a technical measurement. First, you have to get hold of an economical vehicle of transportation; then the traffic men have got to use that economical vehicle of transportation.

I think if we can take up this question that Mr. Rhodes has introduced, and if this Club and the railroad officers here will do their part to find out what is the best type of car that can be suggested, all things considered, that a great step in advance will have been made. I believe at this time that such a recommendation will have great weight with the traffic men. A proper regulation of this matter will save greatly in light loading and empty mileage, and in all the other difficulties we have been meeting in having to get special cars for special purposes; we certainly can do away with drop floors and all kinds of abnormal construction that are now forced into the designs of cars. I hope that everybody will give careful attention to the circulars as they come out, and try to help the committee of the American Railway Association to get together all the data which is needful for this question.

Mr. President, it is the purpose of the Committee on Standard Dimensions of Box Cars of the American Railway Association, to determine the dimensions of a box car which shall be, all things considered, the *most economical vehicle of transportation.*

The standard box car must be of such dimensions as shall make it available for the general use of the railroads of the country. Accordingly, the two most important dimensions—the height and width—will be fixed, not by theory, but by the physical limitations of important railroad clearances. The length will be determined by the requirements of ordinary stowage, and by the matter of economy in construction, maintenance and operation. Therefore, I believe, if mechanical organizations like the Western Railway Club take the matter up earnestly it will not be difficult to define the standard dimensions.

But there are now in existence a large number of cars exceeding the contemplated standard dimensions, many of which have a lowered floor plane and many other abnormal features. They are not economical vehicles of transportation. It is therefore necessary for this committee not only to determine the dimensions of the standard car,

but also to make some provision which shall encourage the railroad company and the shipper alike to construct and use the standard car, and, at the same time, prevent the abuse, while still permitting the use, of the abnormally large cars now in existence.

The pressure to build an abnormal car is largely the outgrowth of freight classification rules. The classification committees, however, are not alone at fault. They have repeatedly asked for a standard car upon which to base rulings. The chairman of the official classification committee, in a letter, says: "The minimum carload weights in effect under the official classification are based, as nearly as possible, upon a fair average of the actual weights of the various articles that can be loaded in what may be considered an *ordinary car*." But what is an "ordinary" car? In another letter the same officer complains that in some cases a car contains "1,309 cubic feet," in others "2,700 cubic feet." Again, the chairman says: "If they (the cars) were uniform in length and capacity it would be an easy matter to provide minimums on the various classes of freight." If, therefore, the "standard car," or the "most economical vehicle of transportation," can be determined and agreed upon, then the classification committee should consider this the "ordinary" car, and adopt it as the "car unit" or basis of measurement for carload rates.

The difficulties of the classification committees lie chiefly in dealing with "light and bulky" articles. There are approximately 2,700 articles provided with carload rates in the official classification; 439 of these may be denominated as "light and bulky." The great variation in the size of cars has made it impossible to prescribe a minimum weight which has any direct connection with the amount which can be actually stowed in a car body. To protect the revenue it has become the policy to name minimums in excess of what can be loaded —then in reality the rate is based, not upon the theory of weight, but upon the theory of cubic capacity; and in such a case the official classification schedule is a cubic capacity schedule, which is incomplete and poorly defined, and which becomes more favorable to the shipper the more overgrown the car becomes. For example, the average actual weight of grain cradles in a 30-foot car is 2,000 pounds; the official classification minimum is 20,000 pounds (fifth class). It would require a car 300 feet long to carry the minimum weight. The larger the car the more cradles can be loaded and the cheaper the charge per cradle. With this commodity, therefore, there will be an

undiminished pressure on the part of the shipper to increase the size of the car until the 300-feet limit is reached. The same principle applies generally in the loading of all light and bulky articles, the demand of the shipper for large cars continues—the railroad company, in the face of sharp competition cannot resist—and the large car evil grows greater and will continue to do so until some radical action is taken to remedy it.

As soon as the classification rulings in effect nullify the weight basis and substitute the cubic capacity basis, then the following dilemma presents itself to the classification committees:

(a) To protect the revenue of the large cubic capacity cars which they have encouraged and brought into existence.

(b) To enable roads which have no large cars, or cannot conveniently supply large cars, to share in the business.

In the attempt to solve this, the classification committees have all been forced to make an effort to define a "car unit." The several committees have handled this upon different theories and with varying success. The different "car units" now in effect in various parts of the country I will now give, using such data as they have at hand. It is expected to give this point further investigation, and any information or corrections in regard to the practical operation of these rules is solicited.

OFFICIAL CLASSIFICATION COMMITTEE.

The official classification committee, to cover this point have adopted the much criticised Rule 5 "E." Under Rule 5 "E" when property is offered for transportation in quantities equal to or exceeding the minimum carload weight, the shipment may be loaded in *two* cars not exceeding thirty-four (34) feet each in length, and charged for on the basis of the carload minimum weight and rate. In other words, *two* 34-foot cars may be considered *one*. The official classification, therefore, confesses that for purposes of computing minimums, their "car unit" is of enormous size. This rule may justly be criticised because of its indefiniteness; moreover, the official classification committee does not seem to have consistently used this "car unit" of measure in working out in detail the weight minimums of their classification.

The rule results as follows:

(a) Encourages the building of cars abnormally large (not the most economical vehicles of transportation).

(b) Is only partially successful in lessening unnecessary car movement.

(c) Is only partially successful in bringing about compact stowing on the part of the shipper.

(d) Reduces clerical work of billing to a minimum.

(e) Makes confusion between railroad and shipper, because shipper orders a car of a specific series of a particular road, in order to secure the greatest dimensions. Unless the shipper is thoroughly informed as to equipment, he does not allow the railroad to take advantage of alternatives which would be equally satisfactory to shipper.

WESTERN ROADS—CUBIC CAPACITY TARIFF.

A cubic foot tariff is in effect on certain roads east of Chicago. The "car unit" is definitely stated as 46 feet long, and 3,800 cubic foot contents. The theory is applied thus: If, when transporting a certain commodity, a car of 3,800 cubic feet were used and the revenue, computed by multiplying the minimum weight by the rate, amounted to $100; then by dividing the $100 by 3,800, it would be found that the rate per cubic foot would be 2.632 cents. If a 27-foot 8-inch car, containing 1,332 cubic feet were used, then the charge for the car would be 1,332 cubic feet x 2,632 cents, or $35.06.

The rule results as follows:

(a) Encourages the use of abnormally small cars (not the most economical vehicles of transportation), as the advantage of C. L. rates is obtained (when a small car is used) on quantities which should properly go less than carload.

(b) Is successful in doing away with unnecessary car movement.

(c) Is largely successful in bringing about compact stowing on the part of the shipper.

(d) Increases, largely, clerical work of agents. (This could be lessened if dimensions were generally stenciled, and also by grouping cubic capacity cars by grades, rather than by attempting to figure to a foot.)

(e) Makes confusion in the communication between the railroad company and shipper for the same causes as specified in "d."

SOUTHERN CLASSIFICATION COMMITTEE.

The Southern Classification Committee covers this point by selecting a car under thirty-six feet in length as its "car unit" of measure. No account is taken of height and width. Increasing minimums are

applied. The minimums increase 10 per cent for each increase of two (2) feet in length of car over thirty-six feet. An objection to this schedule is that the larger the car, the more favorable the minimum becomes to the shipper.

Following is the table :

34-FOOT BASIS.	24,000 lbs. Ch'ge not less than	20,000 lbs. Ch'ge not less than	16,000 lbs. Ch'ge not less than	15,000 lbs. Ch'ge not less than	12,000 lbs. Ch'ge not less than	10,000 lbs. Ch'ge not less than	8,000 lbs. Ch'ge not less than	Per cent Increase
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	
6% cars over 36 and not over 38 feet in length,...	28,800	24,000	19,200	18,000	14,400	12,000	9,600	.20
12% cars over 38 and not over 43 feet in length........	31,200	26,000	20,800	19,500	15,600	13,000	10,400	.30
24% cars over 42 and not over 46 feet in length........	33,600	28,000	22,400	21,000	16,800	14,000	11,200	.40
35% cars over 46 and not over 50 feet in length........	36,000	30,000	24,000	22,500	18,000	15,000	12,000	.50
47% cars over 50 and not over 54 feet in length........	38,400	32,000	25,600	24,000	19,200	16,000	12,800	.60
59% cars over 54 and not over 58 feet in length........	40,800	34,000	27,200	25,500	20,400	17,000	13,600	.70
70% cars over 58 feet in length	43,200	36,000	28,800	27,000	21,600	18,000	14,400	.80

The rule results as follows :

(a) Discourages to a degree the building of abnormally long cars; also stops the construction of short cars. Is deficient, because it ignores the more important dimensions of height and width.

(b) Is successful in lessening unnecessary car movement, when nothing except length of car is essential.

(c) Is, to a considerable degree, successful in bringing about compact stowing on the part of the shipper, although cubic capacity is the real measure, not length.

(d) Does not impose undue clerical work.

(e) Provides a fairly clear method of communication and description between the railroad and the shipper.

BOSTON FREIGHT COMMITTEE.

The Boston Freight Committee, in a letter, Feb. 8, 1898, also recommends *increasing minimums*, but suggests a 30-foot car to be made the "car unit" of measure.

When the *most economical vehicle of transportation* is determined, all rules should be to the end that such standard box car should be given the greatest possible use and the best possible treatment by the

shipper. Exceptional commodities will need exceptional cars, but the rule and the penalties should be such as to make the tendency of all railroads and all shippers toward the use of the most economical car.

A successful rule of freight classification must bring about the following results :

(a) The discouragement of the building of cars *larger* or *smaller* than the standard.

(b) The least unnecessary car movement ; which will follow when the minimums are affixed so as to be most favorable to the standard car. Such cars will then not only be in the greatest number, but also in the greatest demand.

(c) The placing of a penalty upon loose and wasteful stowing on the part of shippers.

(d) The reduction of clerical labor to the lowest degree possible.

(e) The provision of an easily understood method of communication between all railroad employes and shippers.

The following suggestions are given for consideration:

1. Decide upon the *height*, *width* and *length* of a standard box car, the exact dimensions of which shall be determined by features of economy in transportation.

2. Readjust the minimums for light and bulky articles which do not load to the minimum, to the basis of the "car unit" of the standard box car, but so that the charge to the shipper shall not be increased. A method to accomplish this is suggested below.

Ascertain a sufficient list of car numbers which have been used for the actual shipment of the various light and bulky articles ; obtain the cubic capacity of these cars ; make a table :

Box Car Number.	Cubic Foot Capacity of Car.	Minimum Weight of Commodity under Consideration.
A. B. R. R., 100	3,000 cubic feet.	20,000 pounds.
C. D. R. R., 200	4,000 cubic feet.	20,000 pounds.
E. F. R. R., 300	3,500 cubic feet.	20,000 pounds.
H. I. R. R., 400	2,500 cubic feet.	20,000 pounds.
J. K. R. R., 200	2,000 cubic feet.	20,000 pounds.
Total	15,000 cubic feet.	100,000 pounds.

Divide 15,000 cubic feet into 100,000 pounds, and it would show that the result of the present classification for the commodity under consideration was an allowance of 6⅔ pounds to the cubic foot. If,

therefore, the cubic capacity of the standard car should be 2,400 cubic feet, by multiplying this amount by 6⅔, the minimum of the commodity under consideration, or 16,000 pounds, would be obtained, and this would make no change of charge to shipper.

3. Rule that cars *smaller* than the standard shall have the same minimum as the standard car (it being expected that these cars will soon disappear, and while in the service can be kept fully employed in handling heavy traffic, which does not require cars of large cubic capacity).

4. Apply the theory of increasing minimums to all cars, the dimensions of which shall exceed the standard. This will protect the revenue of the large cars, and, from the standpoint of the railroad, offset the reduction made above in "2." Let the minimums increase in a ratio slightly in excess of the ratio of increase in cubic capacity, in order that the construction and use of abnormally large cars shall be discouraged.

5. Stencil prominently all box cars in classes, as A, B, C, D, E, etc., so that there may be provided a method for quick and intelligent description.

6. Publish in the classification a table of increasing minimums, as follows (the figures given being hypothetical, for purposes of illustration):

Class.	Length.	Cubic Capacity.	Minimum.
A (standard)..........	34 feet or less.	2,200 feet or less.	20,000
B....................	34–36 feet.	2,201–2,330 feet.	21,500
C....................	36–38 feet,	2,331-2,460 feet.	23,000
D....................	38–40 feet.	2,461–2,590 feet.	24,500
E....................	40–42 feet.	2,591–2,720 feet.	26,000
F....................	42–44 feet.	2,721–2,850 feet.	27,500
G....................	44–46 feet.	2,851–2,980 feet.	29,000
H....................	46–48 feet.	2,981–3,110 feet.	30,500
I....................	48–50 feet.	3,111–3,240 feet.	32,000

If a classification of a car in accordance with its length, is higher than its classification in accordance with its cubic contents, or vice versa, the car shall be placed in the highest class required by either.

Mr. C. A. Schroyer (C. & N.-W. Ry.): Mr. President, I might say something on this question from the standpoint of the mechanical department. I am specially glad to hear the gentleman make the remarks that he has made on this subject, but as he was speaking, the thought occurred to me that the mechanical departments ought to

have more to say about the size of the cars that are built; at least if they had we probably would not have so many different sizes.

The effort of the mechanical department has been very largely to build the car that the traffic department wants. They came out to the mechanical department some time ago and they said to us, "Here is a fellow who builds a car that will carry six sheep more than ours, and it is marked the same length as ours ; now that will not do." And that thing applies all through the question of car construction. We had occasion some time ago to go into the question of car sizes. We measured the sizes of what were known as standard box cars on seventeen of the roads with which we were running in almost direct competition, and we found that there were no two of those roads that have the same sized box car. They vary sometimes as little as a quarter of an inch, and sometimes as much as two feet.

The size of the car that has been mentioned here as being a typical box car, is 8 feet 6 inches wide. I found that there are but two lines in this list of seventeen that have cars that wide. A very large majority of them have cars 34 feet inside length. Some are 33, and two of them are 36, while the height varies equally with the width, from 6 feet 10 inches to 8 feet. We built for a long number of years cars 6 feet 10 inches in height, and there never was a complaint about these cars until some fellow discovered one time that a car 7 feet 2 inches in height would carry another tier of barrels, so we had to build a car 4 inches higher at once ; in fact, we changed the cars we were then working on. Now, a car 7 feet 2 inches in height carried four tiers of barrels, it met all the requirements, the center of gravity was not so high but that it could be handled safely on the tracks, and we were congratulating ourselves that we had a car about the right size, but it was not very long before we had to change the size of the cars again, because some other fellow wanted a larger car.

This question has been introduced a number of times in the Master Car Builders' Association, but we have doubted whether the adopting of a standard size of box car came within our province. The result is, nothing has been accomplished in that direction, but I assure you the mechanical departments of the roads will hail with joy the establishing of a uniform size of car, if the other departments are willing to continue that car as a standard.

I have no means of knowing to what extent the cost is increased

today for maintaining the various sizes of cars which we must do. The sizes and quantities of materials are very largely increased because of this fact. It is an everyday occurrence that we are called upon to cut timbers to shorter lengths, to dress them down narrower and thinner, because of these conditions. The amount of money that is lost in so doing, the delay that is occasioned, is of such character that it would be a great measure of economy, and quite a saving of time, if it were possible for us to adopt a typical or uniform size of box, stock, gondola and flat cars.

Mr. Robert Miller (Michigan Central R. R.): Some twenty years ago our cars all carried 10 tons. They have grown from 10 tons up to 60, 80 and 100 tons. Our road runs to one of the greatest furniture manufacturing cities in the state of Michigan. Some years ago one company said that if I would put on a car of a certain pattern for their work, they would be satisfied, and take every car. Well, we built a number to conform to their wants, perhaps a dozen, but somebody discovered they were not just right and they were built a little larger. They kept growing from that until they reached 40 feet. Then our president said, "We will stop there; we won't build any larger." Well, we had to build them 45 feet.

This morning I saw that the Chicago & North-Western has a car 50 feet long, and I feel that a remark of a friend of mine applies in this case. He said, "If there is one thing that the Lord does not know, it is what a boy will do next." It is a good deal that way with the traffic department. I have about come to the conclusion that the millennium is just about as near here as a standard car.

Mr. Crapo: The traffic men have put a lot of good thought into this matter, and they are a lot of bright men. By themselves they cannot formulate a set of rules which would give complete satisfaction to all departments of a railroad. All departments must work together in this matter, and I do not believe that any headway will be made if the mechanical department of a railroad enters upon the subject by saying that the blame is not theirs, but that another department is responsible for it all. It seems to me that the time is ripe to define a standard car. The gentleman from the North-Western has said that he was forced to put an extra height on to his car. I think he made money by it. Height is a cheap dimension on a car, so is width; but the growth in height and width has practically already been attained, because the clearances of railroads are nearly filled.

Mr. Miller says the North-Western has built a 50-foot car. No one would care if they built a car twice as large, providing the theory of increasing minimums is adopted. I believe that the North-Western car was built solely to secure cubic capacity, so that by means of this cubic capacity it could hold out inducements to shippers, which, under the present rules, are nothing less than a cut in rates. If a shipper is permitted to pack loosely he will certainly do it, and he will call for the North-Western car just so long as it is the largest car in existence. If the St. Paul, or some other competitor, builds a car still larger, then the shipper will be satisfied with nothing except the St. Paul car. To illustrate, let me say that some time ago official classification rule 5 E, or "two cars for one," was not limited to two 34-foot cars. Two cars of any kind could be used. We have on our line some carriage works, and we had placed, for loading, two Lake Shore furniture cars that were brand new and the largest car then constructed. The carriage people loaded these two cars and billed them as one. I asked, why? They replied that if they packed the buggy tops extended their customer would like it better, and, consequently, we hauled these two cars 105 miles, and after paying the mileage we got less than $2.50 on each car; that was our revenue. Now take hay, the increase in size of the car has not resulted in greater economy to the railroad. It has resulted in the looser pressing of the hay and the use, by the shipper, of greater cubic capacity. It is not businesslike for a railroad to supply unlimited space for careless packing. In regard to full car loading, how much more satisfactory is the coal trade. No railroad would allow, at the dictation of the shipper, a 40-ton car to move with but ten tons of coal in it. Such loading would be apparent, and the unreasonableness of it would be admitted by all. The assurance of full loading is one of the conditions which permits coal to be handled on low rates per 100 pounds. But in nearly all the other commodities, such as lumber, hay, grain, flour, etc., etc., cars are being handled by railroads with only half their economical loads. There certainly is a relation between most commodities and cubic capacity, and the theory of increasing minimums, properly applied, would surely tend to better loading on the part of the shippers.

Mr. E. E. R. Tratman (*Engineering News*): From the remarks that have been made, it seems to me it would be a good thing for this Club to take up what is popularly called the large car question. The New

York Railroad Club took that up in 1896, and had a very interesting report and discussion, which will be found in the proceedings of that club for February, 1896. I do not know that it had any practical effect, except, perhaps, in the missionary direction, as suggested by Mr. Rhodes. It is a very important question, both as to the traffic and the car construction departments, and I think it would be an interesting subject to discuss at some other meeting.

Mr. Delano: There is one point I want to bring up. This is a subject I am very much interested in, and it seems to me the most hopeful thing in it is that a general manager comes to our meeting to talk upon the subject. I feel as though the mechanical and traffic departments might get together when the question is boosted along in this way. I know the traffic men are not blind to it, and I also know that it is the disposition of mechanical men to say: "Oh, well, you traffic fellows have got us into this awful mess; you have fixed a 20,000-pound minimum on light, bulky freight, when you never stopped to estimate what a car would carry; you just made that minimum without reference to the car, and it did not occur to you that the consequence would be that somebody would be smart enough to build a car big enough to hold the minimum, and that all the cars that did not hold that minimum would at once be discredited." The fact is, the traffic departments are fully awake now to the bad condition of affairs which this question of minimum on light and bulky articles has brought upon the railroads of this country. I believe, as Mr. Crapo says, that the time is ripe to take this question up.

Now as to the question of this "most economical vehicle of transportation" evidently we want to get as high and as wide a car as our practical clearances will allow. That does not mean only the clearances on the road or in the yards, but it means the clearances of our freight houses, elevators, etc., where the cars must be loaded and unloaded. If we fix that cross section—and I agree with Mr. Crapo, that we have gone very close to the limit already—then the only variable figure left in the car construction will be the length and, obviously, when this cross section has once been fixed, the carload minimum could be fixed very simply, by simply giving a minimum for the different lengths of cars.

Now, as to the suggestions of the committee of the American Railway Association, about a car 34 feet inside, while I think that a 34-foot car, as generally understood, is about the right dimension for

a typical car (it is a fact, I think, that something like two-thirds or three-quarters of the equipment in the United States is approximately 34 feet in length, and, hence, we would be meeting as nearly the present equipment of the United States by using that length as any), yet I want to ask if this committee has in mind the fact that a 34-foot sill will not make a car 34 feet long inside? Has the committee in mind the report of the Master Car Builders' committee, which reported on the standard dimensions of car sills? Does the committee remember that in buying timber, the merchantable lengths of timber vary with each 2 feet; that, if you cannot build a 34-foot car with 34-foot sills you must buy 36-foot sills, and, hence, waste, perhaps, 18 inches of material?

I merely mention this point, because if we are really considering the most economical vehicle of transportation, we must consider the construction and the maintenance of it.

There was another point not touched on fully, and that is the extent to which the equipment is discredited every time there is a change made. Mr. Schroyer brought out the point that when it was necessary to make his cars 7 feet 2 inches inside, the 6-foot 10-inch car was at once discredited. I haven't a doubt that empty cars are hauled away from stations on the North-Western road which are 6-foot 10-in. inside, and empty 7-foot 2-in. cars hauled in (empties traveling in both directions), when, if there had been a uniform car, there would have been no empty mileage of that kind. The statement is true as to the width, the height and the length of cars, and, in addition, there is the expense of the keeping in stock of all the different sizes of material, and finally much that is still good, and even the cars themselves, must be thrown away, you might say, simply because they are not quite "up to date." Surely this amounts to something tremendous; it is a terrible waste.

Mr. Robert Miller: Just one word more. I have always advocated a standard car; I am fully in accord with the idea. I believe in everything Mr. Crapo has brought forward in his remarks all the way through; but the question comes up, If the matter could be regulated by the minimum charge, why the necessity of a standard car?

However, it is an encouraging thought that, if managers will insist upon that typical car being built, by and by the old warehouse on

wheels will wear out, and it will not be rebuilt, and in that I should be happy.

Mr. Marshall : Mr. Rhodes has said that the committee of the American Railway Association spoke about the clearances of the Pennsylvania railroad. I would like to ask if there are not other roads whose clearances must be considered. We have been looking into the matter of these standard dimensions with a view of determining what we would do in new box cars, and we find that there are several roads whose limits we have now reached ; and if we should consider a car anything like 8 feet 6 inches wide inside, and 8 feet high in the clear, it apparently would not clear on some portions of the Pennsylvania railroad, New York, New Haven & Hartford railroad, and some others. We are not through with our investigations, but it is quite a serious question, as we have no means of knowing whether the clearances quoted us will remain as they are, or will be increased in the future. We believe thoroughly in a standard car, and we would like to adopt it if we can.

Mr. Rhodes : One of the questions that the committee is asking the different roads is, whether there are any physical difficulties in the way of adopting this typical car ; and if so, state what these physical objections are, and whether there is any likelihood of these physical objections being removed within the next couple of years. The idea is to adopt a typical car, which will be a typical car ten years from now, and not merely two or three years from now.

Mr. Crapo : Of course, the Equipment Guide gives a certain table of clearances, but the committee is anxious to have a fuller explanation as to what are the limiting clearances than are given in this guide. If it is only a question of a few thousand dollars on a certain road to change the governing clearances, such an obstacle should not be allowed to interfere with the dimensions or curtail the economies of the typical car. I believe that most roads would change clearances, which could be done without too great expense, if they felt assured that other railroads were working toward the same end, and that a general and substantial betterment in clearances was aimed at, not only by themselves, but by their connections. This would be the case if every one was working toward the pattern of a standard car.

The compiler of the Equipment Guide thinks he will be able to make his Guide more satisfactory if the actual clearances are given.

They are given very roughly in the Guide now, but it will be a splendid thing, in building cars, to have them given fully.

THE PRESIDENT: Before adjourning, I would like to say that I regret very much the lack of time to take up Mr. Shea's paper on "Piece Work" and discuss it, but it must necessarily be deferred until our next meeting. I would also add that the paper on "Piece Work" will not appear in the Proceedings of this meeting, but will be held over until the November meeting, when the paper and the discussion thereon will appear together.

Adjourned.

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Mr. O. M. Stimson: Modern Freight Car Estimating. By O. M. Stimson, 1897. Illustrated.

Pratt & Lambert: Notes on Varnishes and Fossil Resins. By R. Ingham Clark. Illustrated.

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	April	1	"
	May	4	"
	October	3	"
1895,	February	1	"
	September	26	"
	October	36	"
1896,	January	26	copies
	February	1	"
	March	98	"
	April	1	"
	May	1	"
	September	12	"
	October	4	"
	November	12	"
	December	12	"
1897,	January	1	"
	February	1	"
	March	1	"
	April	3	"
	September	1	"
	October	1	"
	November	39	"
	December	188	"
1898,	January	133	"
	February	134	"
	March	55	"
	April	8	"
	May	181	"
	September	165	"
	October	68	"
	November	171	"
	December	71	"
1899,	January	67	"
	February	128	"
	March	47	"
	April	32	"
	May	12	"
	Total	2,096	

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

Published monthly, except June, July and August, by the Western Railway Club, 667 Rookery Bldg.
Club meets third Tuesday in each month, except June, July and August.

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THE regular monthly meeting of the Western Railway Club was called to order at 2 p. m., Tuesday, Nov. 21, 1899, in the Auditorium Hotel, Chicago. Vice President A. E. Manchester in the chair.

Following are the names of those who registered :

Anderson, Geo. T.
Anderson, T.
Ball, H. F.
Bates, Edw. C.
Bayley, R. W.
Benjamin, F. G.
Bentley, H. L.
Brazier, F. O.
Bryant, W. E.
Bushnell, R. W.
Cardwell, J. R.
Carney, J, A.
Carse, David B.
Chase, F. A.
Chambers, J. S.
Clark, F. H.
Cockfield, Jos.
Conger, C. B.
Cooke, W. J.
Cory, C. H.
Crosman, Walter D.
Cushing, Geo. W.
Dean, Nat. C.
Deems, J. F.
Delano, F. A.
Farmer, G. W.
Forsyth, A.
Forsyth, Wm.
Furry, Frank W.
Gardner, J. W.
Gilmore, C. R.
Gilmour, W. L.
Goehrs, Wm. H.
Graham, J. A.
Henderson, G. R.
Henry, C. S.
Hill, Jas. W.
Hone, A. C.
Hunt, Thos. B.
Jackson, E. J.
James, G.
Johann, Jacob.
Keeler, Sanford.
Kelly, C. V.
Kirby, T. B.
Lamont, R. P.
Lowell, W. W.
Lundquist, C. J.
MacKenzie, J.
Manchester, A. E.
McAlpine, A. R.
McMaster, T. J.
Mileham, C. M.
Miller, Robert.
Morris, W. S.
Otto, Oscar.
Parish, Le Grand.
Parisoe, Louis.
Peck, Peter H.
Perry, A. R.
Plaer, F. E.
Rapp, M. E.
Reilly, T. S.
Rhodes, G. W.
Roberts, H. H.
Rogers, M. J.

Sanborn, John G
Scales, R. P.
Schevers, A. J.
Schroyer, C. A.
Scott, G. W.
Shea, R. T.
Sinclair, Angus.
Smart, R. A.
Smith, R. D.
Smith, Willard A.
Stewart, Samuel C.
Sullivan, Chas. L.
Swan, C. A., Jr.
Taylor, E. G.
Taylor, J. W.
Thompson, John.
Thurtell, B. W.
Tratman, E. E. Russell.
Wakeman, C. J.
Wallace, G. W.
Wells, M. E.
Whitridge, J. C.
Wickhorst, W. H.
Wilson, H. M.
Wood, G. S.
Woods, E. S.
Woods, J. L.
Zeleny, Frank.

The Chairman: We have been advised that our President will not be here today, and it becomes my duty to call you to order. You have all received the minutes of the last meeting, and, unless there are some corrections to be made, the minutes will stand approved as you have received them. The minutes are approved.

The Secretary will now read the list of new members that have been passed upon by the Executive Board.

The Secretary then read the following:

J. O. Williams, Manager Magnolia Metal Co., Chicago.
Jas. W. Harkins, care of Wm. Baragwanath & Son, Boilermakers, Chicago.
Frank Zeleny, Special Apprentice, C., B. & Q. R. R., Aurora.
J. T. Slattery, Traveling Fireman, D. & R. G. R. R., Denver.
A. J. Zwart, Western Repr., U. S. Metallic Packing Co., Chicago.
T. Shillinglaw, M. M., Pullman R. R., Chicago.
W. T. Sprague, Repr., Link Belt Machinery Co., Chicago.
Mass. Institute of Technology, R. P. Bigelow, Librarian, Boston, Mass.
Calvin Skinner, M. M., T., St. L. & K. C. R. R., Frankfort, Ind.
Lyman A. Wilcox, L. S. & M. S. Ry., Elkhart, Ind.
Jno. Thompson, 98 Evergreen avenue, Chicago.

The Chairman: The list as read will become members, unless there is some objection. Mr. Smith, has the committee of which you are chairman any report to submit at this meeting?

Mr. Willard A. Smith: I am waiting to submit the same to Mr. Delano, and expect to have it ready in a few minutes.

The Chairman: There being no other business with the Secretary, we will now proceed with the discussion of the paper that should have been discussed at our last meeting, but, on account of lack of time, was laid over. This paper you have all had a very good opportunity to read and to consider the many valuable points in it, and I trust there will be a very liberal discussion of the paper today. The paper is presented herewith.

Piece Work in a Railroad Shop

By R. T. Shea

The object of this paper is to invite discussion on the piece work question for mutual benefit, to outline a plan of handling this system in railroad work, to show some of the advantages both to the company and the men, and to call attention to a few of the pitfalls to guard against in introducing the system.

In this age of great competition in the railroad world, the mechanical department is called upon to increase the output and decrease the cost to the greatest possible extent, and many railroad managers now believe this can best be done under the piece work system, paying for just what is done and no more, and trying to get the plants to as near a commercial basis as practicable.

There are very few railroads today which would be content to pay their engine and trainmen fixed salaries per day or per month, regardless of the miles run ; very few who would be willing to erect large depots or other buildings, or build miles of track by hiring gangs of men and paying them day wages ; very few successful manufacturing companies could live, if they had to depend upon an uncertain quantity for a day's work.

I have often wondered what the result would be if railroad officials would say to their train and enginemen : "We will not pay you by the mile, but by the day, and in heavy business demand the same service you now give us for your fixed rate per day, regardless of the miles run." I believe we will all admit that this would be very unsatisfactory both to the men and the company, and I believe also, after the piece work system becomes thoroughly established in all our shops that both employer and employe will find it just as satisfactory as they now do with the train and enginemen.

When handling freight on the tonnage basis was first introduced it met with much opposition, yet who today, either employe or employer, would consent to return to the uncertain old way of hauling so many cars in a train, regardless of the tons.

It was said in an article recently published by a Pennsylvania railroad official that "times change and we either change with them or we perish." It seems to me that this will be true in shop methods.

Many of our shops are working on a system of a given amount of work for a day's pay, and if the men turn this quantity out the company is satisfied; if not, they are replaced by others who will. It always seemed to me like this was running into a stone wall and stopping there ; that men were simply made machines without stimulating their ambition, and that they fall into a rut and remain there

We will take it for granted that under this system if a man performs a given amount of work in ten hours the company is satisfied to pay him his day's wages, say $2.00. Now, instead of saying to him, We will require you to do so much work in ten hours, say to him, We will pay you $2.00 for a given amount of work, regardless of the time it takes. If he can do this work in seven hours, instead of ten, as formerly, the company is the gainer on account of the increased output for the same cost, and the man is the better off on account of the increased pay. Another decided advantage, both to the company and the men, is that every man under the piece work system feels that he is in business for himself and is personally interested in the output, and will not be content to rely solely on the foreman to get his work or supplies around.

At a recent visit to one of our tool works, in conversation with one of their employes, he told me that his day rate of pay was $2.50 and that under the piece work system he had averaged for the past year $3.19, an increase of 69 cents per day. This he considered a very substantial increase, and was, as might be expected, well pleased, but he said: "The company can well afford to pay me the increase. Under the day system I was given a certain amount of work to do, and when it was done I would notify the foreman, and if he was busy, which is usually the case, it would be some time before I would have another job started, the interval would be put in grinding tools, cleaning up the machine or visiting, but we are now given this piece work, and before the work we have in the machine is finished we look after the next job, going to the foundry or casting-room, if necessary, and personally seeing to it that our work is delivered on time, so that not a minute is wasted, thereby greatly increasing the output, benefiting both the company and ourselves."

It might be said that this is poor supervision, and if we had a competent foreman the men would not have to wait a minute under the day system, but this factory referred to is considered one of the most modern, up-to-date shops in the country.

It should also be remembered that low wages are not the cheapest, as this man's own statement in a measure demonstrates, and also shows the view the men take of it. Men under the day work system work along in a given way day in and day out, no particular incentive to change, but as soon as they are put on piece work they are in business for themselves, and, if encouraged, take hold with new life.

In visiting another one of our eastern manufacturing plants recently, I was surprised to find that all the mechanics were averaging $4.00 per day, the day rate being $2.25, and I questioned the superintendent as to why they could afford so great an increase, and he said that it was the best investment they ever made; the large increase in output and the decrease in cost per piece fully justified it. He said that his company had a similarly equipped plant, if anything more modern, in England, that the English mechanic was paid about $1.50 to $1.60 per day, and that they could ship the product of this American factory to England, and after paying all charges incident thereto it would not cost over 60 per cent of what the English product did, notwithstanding the fact that the American mechanics made $4.00 per day as against $1.50 for the English mechanic.

In talking with a number of the employes in this same shop, in every case

they told me their average pay was $4.00 per day ; that they fully expected to make that every day, and that the only grievance they had was in the event of the machinery breaking down, or some unusual job occurring, when they would be forced to work day work at $2.25 per day. They said they figured their time was worth 40 cents per hour and that they did not want to work any day work at the day rate. They also told me that the only time any new machinists were hired in this shop was in the event of the death of one of the present employes, as the men were perfectly contented and resignations were unknown. This is a point that is well to remember, and demonstrates very plainly that if the piece work system is properly handled, a contented set of workmen is the result.

HOW TO ORGANIZE.

In organizing this system one of the first things to remember is that all of the workmen combined in any shop or department are smarter than any one individual, be he foreman, superintendent or general manager, and that sharp practices or trying to take unfair advantage of the men in any way will react a hundred fold ; absolute fairness is the first essential.

I have much sympathy for the company that attempts to introduce piece work with the idea that the hair-splitting and unfair advantages taken of their men are soon forgotten by these men, like contracts written on sand to be obliterated by the first gentle breeze, and they will realize, probably, when failure is staring them in the face, that those unfair actions were written on the strongest kind of parchment with indelible ink, and that they will have to pay liberally for their folly. If one is letting the contract for a small barn, the total cost for labor of which will not exceed $10.00 or $20.00, and never expects to build another, or probably never again see the man who builds it, he can work on very different lines from the railroad company which is making contracts with its men to last for years, and whose very success or failure depends on the co-operation of these men. It should be remembered that in establishing a piece work system it is not for a day or for a week, but for years to come ; it not only affects one shop or one railroad company, but it affects all ; no speculation in prices should be indulged in, but every job should stand on its merits. As an illustration, if on two jobs one price is too high and the other too low, and if the same man does both, they will average up all right, but if for any reason the same man does not do both jobs, and they are given to two men, then the man who gets the low price job will naturally suppose that the foreman is discriminating against him, and this will cause him to be dissatisfied. The man who gets the high price job will realize that he is being paid more for his labor than it is worth, and if he does not say so he will know that it is unfair to the company. The rule should be to pay for each individual job what that job is worth, and not to depend upon one operation to help the other. There can be no hard or fast rule outlined for the setting of prices. This must be largely a matter of judgment of the foreman and piece work inspectors in charge.

You cannot figure revolution of spindles and feed screws, cuts of tools per second, travel of platens, or other fads, to fix prices that will work in all shops, as it will be found that machines vary according to local conditions, and also men vary according to surroundings, and as has been said recently in a paper before this

club that "hobbies won't work except in the visions of those who ride them." Some advocate what is known as the fixed per cent system. As an illustration, if a man is given a certain operation to do and he works the machine to what the foreman considers full capacity for say ten hours, this time is then reduced 10, 20 and 30 per cent of whatever the agreed scale is, and his rate of pay is based on this reduced scale. If he earns, say $2.00 per day, and it requires a day of ten hours to do the work, the piece work price would then be made, if the 20 per cent scale was in use, $1.80.

I have often wondered if it ever occurred to the people who use this method, that the men very soon find out how they are being handled and are governed accordingly; they may be able to make one or two prices at this rate, but from that time on they will find the men putting in enough time to easily overcome it. It would be far better in many cases to pay $2.10 or $2.20 instead of $1.80, making some inducement for the men to continue to get full capacity out of the machine and consider their interests as well as the company's, dividing in a measure the profit with him.

Our experience has been in establishing piece work prices, that the conditions must be studied and good judgment used in each individual case. If a man by superhuman effort produces a large output of work in a given time, it is not fair to that man to expect that he can continue to do this day in and day out, and some allowance must be made. If, on the other hand, he does not do what is considered a fair day's work, then the piece work prices must be based accordingly.

As soon as the men find out they are being treated in this manner, very little trouble will be experienced in arriving at the proper price to pay for the different operations.

It is very necessary in making up schedules, in the different departments, to make them as plain as possible, for while you may understand what they mean when they are first written, in a few months hence, when foreman, inspectors or managers change, your successors may not be able to interpret your meaning unless your schedules are worded so plainly that there can be no misinterpretation. Care on this point will save many misunderstandings. As an illustration, when making prices I would say:

"Driving axle 8 inches in diameter, cut to proper length, turned to finished size, journal rolled, and wheel fits made, job complete, each axle......$00.00

"Driving box slotted for cellars and shell in single headed slotter, one box at a time, each box, Class A engine.............................. 00.00

'End grain door guides, 3⅜-inch holes punched and 2⅞-inch bosses punched, per 100 pieces, all work........ ... . 00.00

"Engine jacket removed from Class D engine complete, including stripping jacket and cab and storing away in proper place, per engine, all work.. 00.00

"Air pump steam pipe, outside of cab, new, made and covered with asbestos and connected up, all work, job complete........................ 00.00

"Freight car wheels removed and replaced; this includes truck in and out, brake beam down and up, and all other work in connection with this job, per pair............. .... 00.00

"Burning paint off of passenger coach, 50 feet long or over, includes all paint off coach complete, sandpapering car after paint is burned off, all work of every kind in connection with this job, ready for the priming coat, per car...$00.00

"Drill press work—for single spindle drill: Drilling transom for engine tank, ½-inch, 8⅞-inch, 12 13-16-inch, 2 15-16-inch, 12 11-16-inch holes drilled, job complete.. 00.00

"Journaling, fitting, rolling and mating wheels, calipering wheels and marking; this includes all work on an old car axle, everything that pertains to it, each axle, on single head axle lathe.................................. 00.00

These are given as illustrations to show our idea of how schedules should be worded. At the end of each week or each month, a bulletin should be posted in each department as shown in Fig. 1, showing the amount each man earned, and the gain or loss.

MACHINISTS WHO WORKED PIECE WORK.

In ______________________ at ______________________

NAME	Hours worked Piece Work	Dollars Earned Piece Work	Amount Earned per hour Piece Work	Gain in dollars Piece Work	Loss in dollars Piece Work

FIG. 1.

Fig. 3 will be found a handy form when first starting the system of keeping track of the different operations, the foreman giving one of these slips to the man for every job he performs, and when properly filled out it should go to the foreman's office and be checked and commented on. In this way every operation in the shop will soon be noted.

There should be a competent man in charge of each shop or each railway to be known as superintendent of piece work; he should be given charge of the entire department; his duties should be to pass on every individual price used, to study proper organization, improved methods of doing work, increasing the output, decreasing the cost, keeping in close touch with the foremen, men and officials on his system, and allow no piece work price to be paid for obsolete practices, but try to bring about a right condition of affairs. Before establishing a piece work price, close supervision and close inspection are very necessary, and strict adherence to the schedule prices, after they are once established, regardless of what different

PIECE WORK RECORD CARD. No.........................

Piece Work done at..Shop

on..

Commenced at..189.......
(Hour) (Month) (Day)

Finished at...189.......
(Hour) (Month) (Day)

CHARGE TO	Schedule No.	No. of Pieces	PRICE		AMOUNT		CHARGE TO	Schedule No.	No. of Pieces	PRICE		AMOUNT	
			Forward,							Total,			

DISTRIBUTION.

NAMES OF WORKMEN	DATE AND HOURS LABOR PERFORMED.												Total Hours	Rate	AMOUNT	
	Date															
	HOURS															
											Total,					

Charge to..

....Gen'l Foreman.

The value of this card is indicated by figures punched out below.

....Inspector.

Price Checked by	10	9	8	7	6	5	4	3	2	1	Dollars.
....	0	9	8	7	6	5	4	3	2	1	
	0	9	8	7	6	5	4	3	2	1	Dimes.
Entered by	0	9	8	7	6	5	4	3	2	1	Cents.

Fig. 2.

Fig. 2 is a card recommended for keeping track of piece work earning, and should be used in duplicate, by use of carbon sheet, giving the man a copy and sending the original to the office to be entered in the time book. This will avoid all chance of dispute.

MACHINE SHOP.

______________________, 189____

Employe ____

Shed No.______________________Eng.______________________

Commenced ____

Finished ____

Time ____

No. Pieces____

Foreman ____

Remarks ____

____

Fig. 3.

foremen or inspectors may think. Until the price is properly changed, through the office, there should be no varying from it in the shops.

If a man is working by the day, and you desire his pay raised, it is necessary to take it up step by step with the officials, and finally it must be approved by the general manager, while by juggling piece work cards or schedules, the piece work inspector can raise the pay of the men higher than was intended.

It will also be found advisable to have the piece work cards checked, both for clerical errors and the interpretation of the schedule, to see if the inspectors are paying what the schedule intends.

After a man starts to work piece work, and it becomes necessary for any reason to give him day work in connection with it, a record should be made of the work performed day work, stating the reason, and this should be turned into the office for the general foreman or master mechanic to look into. Where this rule is enforced, the day work is soon reduced to the minimum. I do not believe in the differential rate system ; if the prices once established are not cut, and the men given to understand that they will not be cut unless conditions change by improved machinery or otherwise, so as to make it necessary, it will be found that the men will get the full capacity out of the plant.

In making up schedules every operation should be itemized, and a price paid for each operation, and in addition to that, wherever possible, many operations should be grouped under one head, thereby allowing one schedule number to be used for fifty or sixty operations. This will reduce the clerical work in that proportion and also liability to error. It will also be found that this will be more satisfactory to the men, and will help to increase the output, as men who have a week's work in sight will figure further ahead than if they only had one or two hours.

After establishing a fair rate for a given operation, the company should be

willing to pay it, and not want to reduce the price whenever, by a special effort the men make a liberal profit.

It will be necessary to have honest, conscientious piece work inspectors, checkers and foremen.

BENEFITS TO THE COMPANY.

In introducing this system in a railway shop, as a rule, it is a complete change of paying the men and operating the plant, and it is not to be wondered at that it meets with some opposition; the men are nervous and scared, and imagine all sorts of things, the principal one being that their wages are to be materially reduced, and while in this frame of mind the utmost patience and tact on the part of the men in charge should be exercised. After having passed through this stage, and the men see that instead of getting less pay and worse treatment their conditions are improved and their pay increased, the change may be considered fairly started.

Happy should be the superintendent of motive power or general manager who, upon investigation, finds that after a year of persistent effort only 30 or 40 per cent of the work is done piece work, as that will show to him that the experience thus gained is invaluable, and that the remaining 60 or 70 per cent will be handled very much better from all standpoints.

The prices paid in other shops should not govern in yours; each shop should stand on its own merits and work out its own salvation; the classifications and systems of one shop may be a guide to help in another, but the conditions, facilities, and ways of doing work vary so much in shops on the same system that the prices applying in one shop will not apply in another. Prices should be based on thoroughly competent workmen and the standard of the workmen elevated as much as possible. The prices should be based on full capacity of machines, where the holding back practice is not resorted to. If this is done, it will be found that the ordinary or slow workman will soon fall in line with the best. If this is not done, and the price is based on medium workmen, the standard of the shop will be lowered, and the best men dragged down, and instead of elevating them you will be lowering them.

It will also be found, as a man said to me the other day in regard to the output of an erecting shop, that conditions are widely different between piece work and day work. This man said that while they were working day work in their department, the foreman was around hustling a gang of twenty men, trying to make a creditable showing, but now that the case is reversed the men in the gang were after the foreman demanding that they be kept busy, and work furnished them in advance; that notwithstanding the fact that the force had not been increased, the output of the shop was double, their former average being six engines per month, now twelve engines.

The quality of the work was also improved because, under piece work system each man is responsible for what he does, and if it is not done right it must be done over at his expense.

A roundhouse foreman called my attention to a case, the other day, where he formerly employed four machinists on running repairs, and now two do the work;

that formerly it required most of his time looking after them to see that the work was done on time, but since the advent of piece work he pays very little attention to this, aside from inspecting the work ; that the men are looking after him to see that they are given all the work that comes in, and that the back shop men are not called on to take work that they can do.

In starting a gang of four men recently to work on freight car doors, after discussing with them the price that we proposed to pay, and that being agreed upon, they were asked what they could offer to help the cause along, the first thing that they wanted was that their force be reduced one-half, and that benches and tools that were used by them for years without protest be changed and rebuilt, as they would not do under any circumstances now.

The desired changes were made, and two men now do more work than was formerly done by four men.

In one of our tank rooms we had a gang of ten men apparently working hard ; piece work was introduced, and now we have five men.

I believe it is generally considered that piece work properly installed will effect a saving of 30 per cent in nearly all departments. This is, I think, a conservative estimate, and will be increased or decreased, according to the conditions and supervision.

This is one of the arguments used against piece work, as it throws so many men out of employment, and yet how many men are found idle who are willing to work? It is simply a modern condition of affairs with which we are confronted, and we have to meet it as we meet anything else in the line of progress.

In days gone by fifteen or twenty miles per hour was considered a satisfactory speed for our trains ; today the public are demanding from sixty to seventy.

PITFALLS.

The management should not lose sight of the fact that many foremen get scared as soon as piece work is introduced ; and, if their men make a little money, are at once ready to use the scalping knife and cut prices. If we analyze this we can readily see the folly of it. Suppose, as an illustration, we started a department on piece work prices carefully made. Say the day rate is $2.00, and some men by a special effort will make $3.00, or perhaps $4.00, per day on some special operation ; we then cut the price so that by the same effort this man will barely make $2.00. The result will be that the men will say : "What is the use of making any more than wages? they will cut the rate." And your men from that time on simply make the time fit the price, regardless of what they could do.

My attention was recently called to an operation in a shop on a machine that paid $4.00, and the man barely made wages, requiring thirteen hours to do the job. The same operation in another shop, casting made at the same foundry, pattern number the same, was paid for at the rate of $3.30, and the man in this latter shop had performed this work in six and one-half hours. In talking with the man confidentially who used the thirteen hours' time, he said that he could do this work in seven or eight hours, but that every time he had made any money his schedule had been cut,and there was no use to make any further effort, and he simply made the time fit the prices. In talking with the man who performed this operation in six

and one-half hours, he said his prices were never cut, and the men tried to make all the money they could at all times.

Now, figuring that the man who did this work in six and one-half hours made 50 cents per hour, or 20 cents per hour more than it was calculated he would make, the company paid him a net profit of say $1.30. Figuring this machine is worth $1.00 an hour to the company, it received the use of the machine for six and one-half hours more, equal to $6.50, and 70 cents cheaper price makes the net gain for the company $7.20. I believe they can well afford to pay this workman the extra profit of $1.30, leaving them a net gain of $5.90.

We sometimes think that we can calculate very closely on the capacity of a machine, but experience has proven that we cannot calculate the capacity of a man ; and if by superior ability and extra hard work some men make big money, I should say let them make it. The increased output and decreased cost per piece amply pays the company.

Whenever I read that piece work has increased the output in any shop 16 per cent, and increased the pay of the men only 8 per cent, I say at once: "There is a field for a piece work expert, and the hold back process is in full sway." Whenever men do not make more than 8 or 10 per cent over their wages, you can rest assured there is something wrong, and it will bear investigating.

I noticed an article going the rounds in the mechanical papers, describing a car shop whose output is fifteen cars per day. This article describes how perfect the system is and what is expected of each man for a day's work, and how well the men work.

I would like very much to see these same men in this shop paid so much per piece for the same work they are now doing, based on the time they now consume in each operation, with the distinct understanding that the prices would not be cut, and that there would be no limit placed on their earnings. I believe if this were done, the managers of those shops would be surprised at the increased output and the increased pay their men would make. Proper supervision will, of course, accomplish a great deal, but nothing appeals to a man like his pocket-book.

Piece work develops specialists ; experience has proven that men like to do the same thing day after day ; they prepare for it, get good tools and better facilities for doing the work, and this greatly increases the output as well as the quality of the work, because men become experts in doing the same class of work all the time.

I also find that men are very slow to resign piece work jobs, far more so than when working by the day, as there seems to be a certain fascination where the amount varies according to the energy displayed.

I noticed an article going the rounds of the press wherein 200 blacksmiths, wagon makers and laborers were on a strike. This article says that previous to going on a strike, although unorganized, the men sent a committee to the managers asking that their wages be restored. This was refused, but the men were told to go to work at the piece work scale and, if the former wages could not be made, a satisfactory arrangement would be made with them. Instead of the former wages, the men by working harder and longer hours, could earn $1.25 to $1.40 per day. If this is true, is it any wonder that the men were dissatisfied, or the piece work system a failure?

Care should be taken to see that, if the men make proper effort, they should earn more under the piece work system than by day work ; this will insure its popularity from the start.

If your men lose money from the start on piece work, instead of having a contented set of men you have a discouraged set ; and there is nothing harder to handle or get results from than a discouraged set of workmen.

We should not forget that the men have rights and feelings, as well as the company. If the piece work system is properly handled it protects the company and is equitable to the men.

By the day work system, as every employer knows, there is too much temptation to "soldiering." The foreman must be constantly on the alert, urging his men or watching them to see that they do not lose time ; and we all know by experience that while the foreman may for a time be extra vigilant, in time he becomes more or less careless. There may be individual cases of hardship, real or apparent ; but there will always be, even under the day work system. The poor workman drags behind and is unable to keep up his end ; he loses time and money and finds himself at pay day with an unsatisfactory check. But the good workman has no cause for complaint, and always increases his salary.

The *Engineering Magazine* for June, 1899, in an article, says : "In the writer's judgment, the piece work system with its various modifications is a manufacturing system good for every class of work which can be systematized at all ; and, moreover, its adoption is in accordance with and progressing in the direction of modern manufacturing practice. It is on a far broader foundation than the premium system, and is a long way from being the 'abandoned experiment' that some writers claim. It is the most direct, simple, and therefore effective method of building up rapidly and getting the greatest value from a high or any degree of organization, wherever such is possible."

From both the manager's and engineer's point of view it is of value at the start, naturally progressive (a building up process) and of almost unlimited possibilities in lowering the cost of production, increasing the organization, and rendering automatic the operation of a manufacturing works. Where it has failed it has failed because it has been totally misunderstood or misapplied.

The Chairman : I will ask Mr. Shea if he would like to precede the discussion of the paper with any remarks.

Mr. R. T. Shea (H. & St. J. R. R.): Mr. President, I presume everybody has read the paper. I have done my part ; I want to hear the paper discussed. In the advance copy which was published last month, on page 4, there was one line that was blue penciled, but got in accidentally, but it is cut out of this paper. It said, "In many cases we pay more for piece work," etc. What was intended to be conveyed by that line was given before and after, and I wanted that line erased. If there is any question pertaining to the paper

that I can answer, I will be glad to do so before the discussion closes.

The Chairman: The Secretary will see that that line is erased. I hope the members will avail themselves of the opportunity, and use all the time there is in the discussion of this paper, and not wait to be called on individually. Mr. Deems, suppose you give the paper a start.

Mr. J. F. Deems (C., B. & Q. R. R.): I have not studied the paper with the care that its importance deserves, and fear that I am ill qualified to discuss it very much in detail; but, having had some six or seven years personal experience in the practical introduction and development of piece work in railroad shops, I may have absorbed some ideas of a rather general character, possibly some of them right and some of them wrong, that might interest the members; and I would say that during that time the thing that has specially impressed me is that this question of piece work, or piece rate, as we should really call it in its broadest sense, is much more far reaching and much more vital to the railroads—I am not sure but that I might say to the industrial progress of this country—than most of us realize. I do not believe it is too much to say that it is one of the factors, and by no means an unimportant one, in the evolutionary process, or, if you are pleased to call it so, the revolutionary process, that is taking place at this time, and which, if we read the past aright, avoid the mistakes and profit by the experiences of our brothers across the water, is surely destined to make this country the workshop of the universe for the next century. I think I venture nothing when I say that the difference between the English day rate and the American piece rate was one of the important factors, if not the most important one, in securing recently for the manufacturers of this country a contract from the city of Glasgow amounting to something like fifteen millions of dollars; and this is only one of many such occurrences that have attracted the attention of the world in the last year or so. I realize that a great many might feel, and perhaps would not hesitate to say, that it is more the improved machinery, the labor-saving appliances that we have introduced in this country, than the mere matter of piece work; but if you follow that question back a little further, and ask yourselves what has brought into existence this labor-saving machinery, the fact will immediately present itself that it was the piece worker who used his brain in devising means by which he could do a little more work and make a little more money;

so that, with the introduction of improved machinery, you will often find that piece work is the element back of it.

I believe it is safe to say that that system which, in the largest measure, brings into play the individuality and secures the earnest co-operation of the greatest number of employes, is the one that will prevail. And really, when we come to think of it, what is there in the day rate system to bring about this desired result, except the individuality of the leader? and we should by no means underrate this, as it is certainly a very important factor. I think it is safe to say that it is possible, under certain conditions, to get better results with a good leader and a poor system than it is with a good system and a poor leader. But the question of the individuality or personality of the leader is an uncertain one, and any system that will minimize, even in a slight degree, this element of uncertainty is surely a distinct gain.

I have said, and I expect every man here has occasionally said, to some man around the shop, when we caught him loafing, that his time belonged to the company. I have, and I expect others have. Now, in doing that, we have shown that our ideas of what the man really did owe the company were quite vague, and at the same time we conveyed an altogether erroneous but willingly accepted view of the situation to the workman—simply a question of putting in time. When you hear a shopman say to his mate, "How much time did you get in last month?" he has expressed the only measure of his capacity that he recognizes and the only element in which he is interested—simply the putting in of time. Not so with the piece worker; he wouldn't put it that way. The output is the vital question with him, as this, and not the "time element," determines his pay.

Then, again, you take it with the time rate worker; there is—well, you might say there is a triple temptation for him to do as little as he can. In the first place, it is easier; in the second place, increased effort does not mean increased earnings; and in the third place, so long as he does not sacrifice anything, he is entirely willing to reduce his own output up, or rather down, to the limit of safety, in order to help make a job for his neighbor; and this last view of the situation is constantly paraded before the workmen by probably well-meaning but certainly misguided labor leaders, who do not seem to see that that method, followed to its logical conclusion, will sooner or later kill the goose that lays the golden egg.

These things have been forced on me, as I say, in the last five or six years, when I have been almost constantly engaged in introducing and developing piece work in railroad shops.

When we take what may be, and is in many places, called the "stint" system, where a certain output is considered a day's work for a man and he is held to that amount, I think there is really less in this to stimulate individual effort and bring about that spirit of mutuality so essential to the best results, than there is in day work. It seems to say to each man, "this much and no more." It limits him both up and down. I am not sure I am right in that, but that is the way it has impressed me from the study I have made of it. The system seems to assume an almost divine wisdom lodged with the foreman or other officer which enables him, off hand, to decide the capacity of each man ; this system smacks too much of the "boss" idea to ever prove an important factor in developing a spirit of mutuality.

Personally, I would like to see that word "boss" stricken from the railroad vocabulary ; it belongs to an age long past, and has no place in our modern railroad development.

Probably no one will dispute that, where applicable, a well-arranged system of profit sharing is perhaps the ideal system, and in many respects the nearest approach to that is perhaps a piece work system arranged on a basis broad enough to hold both the proprietor and the workman, or the general manager and his subordinates. And woe betide the railroad company whose officers undertake the introduction of piece work with the idea that the profit is all to be on the side of the company, for it is entirely safe to say that in the end it will be disastrous to both sides. But if it is undertaken with that spirit of fairness to which both the company and the men are entitled, the results will probably surprise the most skeptical. There is so much to be said on this subject, that one hardly knows where to commence or where to quit, and possibly it is best not to say anything.

There is one thing in connection with the introduction of piece work. We should not be surprised that the men look upon it with suspicion. They have a right to do so, owing to the zeal or cupidity of some who have undertaken its introduction in the past. I feel that they are fully entitled to that suspicion. Another thing about it :

In introducing it there should not be any star chamber proceeding. Now I want to say right here, there is not a thing about piece work that I or any officer can know that the men will not know; not a thing. So let them get that information from the right source, and get it right in the start. I do not believe there is anything to be gained by trying to hide anything, or proceeding in the work in such a way as to have the men think they are not going to have all the information, for they will get it; there is no question about that. And I furthermore believe, in the introduction of piece work, that wherever it is possible to do so, a schedule of prices should not be taken out and given to a lot of men to start in to work on without first consulting the men about it. I realize it is not always possible to do that; in some instances you may be compelled to make your prices as best you can, and let the men try them, but wherever possible to consult the men about it I think a great deal may be gained by it. Take the men into your confidence to that extent, in fact, to almost any extent for that matter, and give them to understand, not only by assurance, but by every act in connection with the introduction of the work that it is purely a business proposition, and one in which they are interested, and if this is done, I feel safe in saying that it will not be long, that is my experience, at least—until we are surprised to find how eager and ready the men are to meet us half way in this matter, because they see it is a business proposition and they see that they are interested in it and see there is money in it for them.

There is another point I wish to bring out just here. When men go to working at piece work they will devise ways and means of increasing the output. When they do that, the men should have a fair margin of profit on such tools or improvements as they devise. There will be no loss by letting them share in the profits of the improved methods that they can work out themselves. It encourages them, and furthermore, I believe just at that point it sometimes happens that some foreman who, perhaps, is not as broad gauge as he might be, will not be inclined to encourage a thing of that kind, and it is well to keep a sharp eye on him. It is astonishing how closely the men will watch anything that affects the output when they are working piece work. Not long ago, in a shop I am connected with, we had a small engine that runs a flue plant and some other boiler shop tools, and it broke down and was out of service for something over a week, the main shaft being gone. Finally it was connected

again and put in operation; the engine started, the men went to work and they only worked about two hours when two men came in and said, "That engine is not running fast enough." "Well, how do you know?" I asked. They said, "We can not get out work fast enough with it." A speed indicator showed the engine was only running 275 revolutions per minute when it should have been running 290 revolutions per minute. It did not take them long to catch on to that loss of 15 revolutions a minute. Now I do not think they would have done that if they had worked at day rate, and that crops out in very many ways indeed. It is simply a question, in one sense of the word, of taking the men into partnership; they become interested, not in the hours they put in, but in the work they turn out, because that determines their pay.

What Mr. Shea said, a minute ago, about setting a piece work price at a rate somewhat higher than the day rate, there are, doubtless, instances where it is possible to do that. There is no doubt in my mind that you might have a man in the shop of exceptional skill and ability, who could do work by a special effort in a period of time that, if you set the price according to his output you would not have another man in the shop that would make his wages, and that would not be fair. You can not have every man of that kind. You have got to take the average.

Now, in talking about this matter of taking the men into your confidence, there is no question but there are, here and there, some men who cannot be treated just that way; they are unfortunate, but there is only one remedy for them; "out, and forever out," is the fate of the recalcitrant.

On page 2, it speaks about the high rate paid in one plant on piece work, as compared with the day rate, and about the product being sent to England and sold, etc. Now we all know that recently this has been true, and there is very little doubt indeed that it is traceable to the question of piece work. Also, on page 3, it says: "You cannot figure revolution of spindles and feed screws, cuts of tools per second, travel of platens, or other fads, to fix prices that will work in all shops." That is certainly correct. I do not believe that you can walk into the shop and figure the number of pounds of cuttings per minute, and the number of cuttings per hour, and base your piece work price on it. There are altogether too many elements

that enter into the question to reduce it to as simple an operation as that.

I also notice, on page 7, something is said about the advantages of grouping piece work ; that is, while it may be necessary to make prices on elementary operations, it is not necessary to have those prices for the men who work at it at all times. I think a great deal is to be gained in that way. I had an instance of that some time ago in our boiler shop with a gang of men to whom the foreman had given work enough to last ten days or two weeks, saying to them, "When you finish that job, go to that one ; and when you have finished that job, go on to the next," and so on all around. Now, when they came to this first job, where one man could be spared, he went over and surveyed the situation for the next one; he got some tools that would be needed, and they made ready and had mapped out everything, so that when it came to the second job they were all ready and everything moved along without interruption; and so it went from one job to another ; and it is really in those things that the great advantage of piece work occurs. It is in the fact that you get the men working with their brains, but they won't do it unless there is something in it for them.

The Chairman : Gentlemen, this is a paper that is equally applicable to the car department and the locomotive department, and all departments, in fact ; so do not hold back because you are not in the right department, because you are today. Mr. Miller, you ought to have some decided views on this subject.

Mr. Robert Miller (Michigan Central R. R.): Mr. Chairman, I do not know that I have any very decided views on the subject. I note the writer of this paper says that it is to invite discussion. He also says that anybody undertaking to introduce piece work has his sympathy. I have never yet introduced piece work, and I am entitled to no sympathy. However, I have investigated considerably with regard to it, and up to the present time I have not found anything in the introduction of piece work that would, in my judgment, under the conditions obtaining on the road with which I am connected, be of any advantage. I can conceive how a great many locomotive and car manufacturing establishments must find great advantage in it, by the fact that they have specialties, such as links, rods, pins, cross-heads, everything of that kind that goes to make up a locomotive. There is enough volume of that kind of work to keep

a man employed all the while. The same might be said of the car department of our great manufactories of cars, where they can make doors, lay the bottom, put up the frames and put on trimming. It seems to me that all might be done with great advantage to the manufacturer. It might be said, too, and I can conceive that roads like the Chicago, Milwaukee & St. Paul, the North-Western, the Chicago, Burlington & Quincy and the New York Central, where they have a great many locomotives, would have enough specialties to keep men constantly employed, or nearly so, on any specific work, and would find it an advantage; but not the smaller roads, where they have from three to five hundred engines. With our road, we are obliged to run two central plants, one in Canada and one in Michigan. In Canada we have 133 engines, and on the Michigan divisions we have 338 engines. For the volume of work in each one of those places I have not been able to find that there could be any advantage in piece work. Some of our friends have given piece work a trial, and after a careful investigation I have found that none of them produce their work any cheaper than we do, and in a great many instances we are producing it cheaper than they are with piece work. I do not want to be understood by what I say that I oppose piece work, because, as I said, I believe there are conditions that would warrant it.

The writer refers to conductors at a fixed salary. I can hardly conceive that that is a parallel case with shop work—that is, conductors and enginemen. There is no material required. In regard to tonnage, twenty years ago our cars were all ten tons, or nearly so. If managers could have foreseen what the advantages would have been in establishing standard cars, there would be very many vexed questions solved, because the number of cars in that case would govern.

The writer speaks, on page 1, of basing prices on the amount of work that had been turned out in the year. My experience has been in that, that I have had more success in the introduction of improved machinery and improved methods. It may be, if I had had piece work, that the men themselves would have invented better methods; I do not know.

He speaks of the revision of prices. It seems to me that this is a matter that would be attended with some difficulty. I know of some establishments that have established a price, and after the price was established the men were making more than they considered they

ought to make. Now, was it fair, after they had improved the methods and fairly earned the increased pay, to reduce it? The information given in establishing piecework, for anybody that is contemplating it, must be invaluable.

In the matter of pitfalls, I see that even for those that have established piece work there are a great many things to be taken into account. The paper will almost discourage us, in that line, to undertake it.

In the matter of piece work, I notice one little item on page 9 with regard to the making of car doors. That special matter I took up from what our friends have given us in the way of piece work, and compared them with our shop cost, and found that we were making those doors for 30 per cent less than they were in every case where I got information; and the comment that I have to make is, I think they must have had a pretty bad foreman, or they certainly would have made the improvements mentioned there.

It seems to me that the conditions govern to a large extent, and I can not find, so far as I have investigated, that there is any advantage, or would be any advantage, to the Michigan Central road. At the same time, I am still investigating. My foreman at Jackson has been at work for a long time to find out what the cost of producing certain things is. Then, if we can get piece work prices from our friends who have got it established, perhaps we may be better able to form a judgment.

Mr. B. W. Thurtell (Pacific Boiler Works): Having read the paper on piece work carefully, I have come to several conclusions. One conclusion is, that men doing piece work become a part of the machine, and lose their individuality. What I mean by that is, the men who are doing piece work in a certain line, who have any quantity on hand, rush it through without regard to quality, so as to get it off their hands and pass the inspection of the foreman. If the foreman fails to pass it, they say, "He is too particular, because we are doing piece work and want to get a little more pay." The reason I speak of this is, I know a case where men were doing piece work, boring out cylinders. Another man was doing piece work, fitting pistons into the cylinders. When the pistons came in, they were all too small for the cylinders. The man who bored out the cylinders said that he had bored them out as he was told to, the proper size. The man who made the pistons also said he was doing as he was told,

and between the two the company had to pay for some one's mistake. The only remedy was to make new pistons for those cylinders, or to make new cylinders for the pistons already made.

The mechanic that does piece work entirely, is limited as to the amount of work that he can do in other directions. For instance, if he is boring out cylinders for any length of time, and there is no more work of that kind to do, he is put on other work, where he probably can not accomplish very much. He then begins to growl because he is not making a day's wages. There is a kick right off.

In the matter of turning up axles, suppose they are to be 8 inches in diameter, and they are a little short, a little small, or are not quite true, who should pay for it? The company would have to put them in the lathe again and adjust the tools, paying more for them than had they been done right the first time they were in the lathe. It is pretty hard for a mechanic on piece work to go directly to the foreman. The foreman does not go to the manager and say, "Now, how much can we do this for? and how much do you think this is worth?" but he fixes the scale of prices, as a rule. I remember, when I was in the shop, the foreman used to come to me while I was doing piece work, and say, "I will give you so much for doing so much work," and I used to rush the work through to get out so much work a day and make fair pay, and some of that work had to be done over again. That is our experience. In doing piece work, there is oftentimes material at hand that has been finished, laid aside and not used for a great while; and when it comes to be used, you find it does not fit. Perhaps that man has left the shop and gone to some other shop. Who has to pay for it? The company has to pay for it.

Of the men who are working on piece work, one man can turn out a little more work than others, and the man that is making the most money is satisfied, but the other fellow says: "Well, you have got a better job than I have; you can make more money. I do not think the foreman is treating me fair. I think he ought to turn this work around and give it to me part of the time and you part of the time." The fact of the matter is the foreman has probably given it to the man who can turn out the most work, and he is possibly right.

I know very well it is a bad custom that has become almost universal today, that the men are trying to get in a day's work and get their pay, without respect to the benefit the company is deriving

from their work. I know that full well; but by putting them on to piece work, I do not know that that betters it. I do not know how it can. Piece work might do in some very large shops, where they can keep a man six months at a time, or a year, on one class of work. After a while the men become dissatisfied; a boy is put on the same work, and given boys' pay for doing men's work. I know of one shop where they have boys that bore out cylinders. The boys are turning off cylinder heads, and yet they are only getting boys' pay, and are taking the pay away from some good mechanic. The work is not done well; the work has to be gone over again; it has to be inspected, and we do not take into consideration the time of the man that has to inspect this work, either. In piece work you have to keep men doing nothing else but inspecting other men's work. In some work where piece work is done, and where parts are hidden away so they can not be seen until the machine is put in operation and the effects show themselves, then there is nobody to blame, only the shop in general.

I know of one engine firm where they had been putting the engine men all on piece work; in fitting up the governors the studs were not placed in the proper place, because the holes were not drilled in the right position in the arms of the wheel, and were too large besides; also, the studs being a trifle small, and held in place by a single nut, a rat-tail file was used to make the parts go together. Such defects never show until the engine is in operation, when a break occurs, with no one to blame. This is one of the results of piece work. On the other hand, where companies employ conscientious men and good mechanics, the work is well done and does not have to be gone over again. The trouble is that a great many of our shops have in their employ mechanics who are not conscientious; but where shops weed out those men and get good, conscientious men that are sober, industrious and inclined to make an honest living, trying to support their families in comfort, and not trying to support saloons, you will find men who will do their work well. If you send out any of these men anywhere to a repair job, you will know, when that job is done, that it will not have to be gone over again. It is possible that it can be done by piece work. Some work does not require very much attention; I understand that very well; but in the case of work which requires some skill, it should be done by good men, as what is worth doing at all is worth doing well. Work that is worth anything is

worth a man's putting his time and energy into it, and the man that is putting his heart and soul into the work will be most successful.

THE CHAIRMAN: I notice we have Mr. Rhodes with us today, and this paper refers to the fact that a company would not undertake by day's work to do a piece of grading, or to do construction work; that they would do this, I suppose, by piece work. I would like to have Mr. Rhodes state whether he has thought of the matter in the line of road work, section work, or anything in that line, handled by piece work.

MR. G. W. RHODES (B. & M. R. R. R.): Mr. Chairman, I do not know that I fully heard the particular question that you asked me, but if you will let me say a few words without answering the special question, I will do so.

To start with, I am a strong believer in piece work, and I advocate it wherever it is practicable. I qualify this by saying that I mean piece work properly conducted. With any kind of work, whether it is day work, or whether it is piece work, it can be abused; day work not properly conducted is not satisfactory, and piece work not properly conducted is not satisfactory.

I have listened to two or three of the last speakers, since I came into the room, and I have been quite interested in their remarks. I think that the one thing that we do not want to lose sight of is the fact that the majority of the manufacturing interests who have to look after the cost of things carefully, have generally discarded the day work methods and have adopted either the stint work or piece work. That not only applies to rougher work, but to the finest work, even watch work, and gunnery; the most accurate work that is done now is on the piece work basis.

Some years ago, when this question first came up, I was rather on the fence as to what was the proper position for a man to take in regard to piece work, and in visiting the railroad shops at Altoona, where I learned the trade of machinist, one day I noticed one of my old associates working on a lathe; he was a first-class mechanic. At that time the rates for a first-class mechanic were 27½ cents an hour; he was a good, all round mechanic, and, rather to my surprise, I found him in the wheel shop turning up chilled cast iron wheels. I thought that it was rather a come-down for a first-class mechanic to be on a lathe turning up the treads of cast iron wheels, and I went to him and said, "Hello, Jim; what are you doing here?" He looked up

in a quizzical way, and replied, "I am turning up wheels." I said, "Does it pay a first-class mechanic to be turning up wheels?" "Well," he said, "the job pays me 50 cents a wheel, and I turn out six wheels a day. I earn $3.00, and that is quite satisfactory to me." I then remarked to him, "Well, I do not quite know about this piece work. I never liked the idea of piece work, because when piece work men begin to make pretty good wages, the boss will come around and cut down the piece work prices." Well, he looked up at me out of the corner of his eye, and he said, laughingly: "Don't you know how many times we loafed on the company's time, at day work, and have drawn money for it? Your objection is no argument at all." Day work is not perfect, and it does not necessarily follow that changing piece work prices will dissatisfy men working by the piece. Fair minded men know that by the day they have often earned money they were not strictly entitled to, and when through piece work it is discovered the rates are too high or too low, they will not object to a proper adjustment of the prices.

I do not know if it has already been mentioned, but I can cite one or two cases on a road where piece work has been introduced, and treated fairly, where one or two men have actually come and said to the man at the head of the shop, "This rate is too high; I can do this work and make enough money at a less rate." This is the result of piece work, by fair minded men, properly conducted.

I have another instance which interested me quite a little. We have recently been starting up a tie plant on our road, and we handle there, or expect to handle when we get under full way, about 2,500 ties a day. Here is a place where it is very important to know just what it is going to cost to do the work. Whether we do it by piece work, by day work or stint work, it does not matter; but whoever is in charge ought to know what is a fair number of ties to handle per day per man; the work is not intermittent, there is enough of it to keep a given number of men going all the time. The instance that came up was this. The foreman started in loading ties, and he had his gang of men just started off with the first charge; he had only three men, and he was timing how long it took them to load the small tram cars for the retorts. These men loaded three cars in one hour and a half; there were thirty-three ties put on each car. With that the foreman went away and left the men to work alone. When he came back, in the course of three hours, he found the three cars had

been increased by three more cars. This shows that if this work is done by day work, either the foreman must be there to watch and see that the men work satisfactorily, or that a fixed price per tie must be established if the men are to work without the supervision of a foreman. Now mind, I do not mean an unfair price; I mean a fair price, and by fair price I mean a price at which these men will be able to earn more money than they would by the day.

To answer Mr. Manchester's question a little more specifically, I do not know yet whether much track contract work has been started. I rather fancy not. I did hear of its being started at one time on the Pennsylvania Railroad, but there are so many conditions that come in, in the way of getting track men, that I question its practicability. At the present time, in the west, it would not be very practical; there is such scarcity of men, and there is such a demand for labor, that one has got to be very cautious in handling labor in order to retain it.

THE CHAIRMAN: Mr. Henderson, can not we hear from you on this subject?

MR. G. R. HENDERSON (C. & N.-W. R. R.): I have not very much to say on this subject. I think it is one in which we are all interested, and I agree with Mr. Rhodes entirely that it is the ideal way for manufacturing purposes. Every railroad shop, if it is only run for repair work, has a good many articles that ought to be manufactured in the shop, such as driving boxes, shoes, cross-heads, oil cups and brass work of all sorts, and it seems to me that this lends itself very readily to the piece work arrangement. We have done a little of it, but not very much. In regard to one system which has been tried in our shop, I have some sheets in my hand which go rather extensively into the method, and show how it was worked up. Take a certain operation, for instance, planing up a set of driving boxes. There was a special apprentice, a young man, put right by to watch the operation; he kept the time of all the different operations in detail during the finishing up of these boxes, and kept the number of minutes of each operation, grinding tools, taking one cut off one side, and taking another cut off, and going into the whole process, and after these were summed up, the schedule was looked over by the foreman and such operations as seemed to be more numerous than necessary were eliminated. In other words, if the man made three cuts where two would seem to be plenty, it

would indicate either that there might be some little loafing done, or two much metal removed, and all the necessary operations would be taken as the price to be paid for the article. Of course that, in some respects, might look at first to the men as rather a decided cut, but if they see that it should take only a certain amount of work, and that work is paid for, it would seem like a very fair way of doing it.

There is another way that has occurred to me, but I do not know whether it would be entirely practical or not. However, I would be glad to hear it criticised. It would be on this basis: Say a man making two dollars a day would be able to turn out ten articles, which have therefore cost the company 20 cents apiece. Now, if they should say to that man, "If you can make any suggestion in regard to special tools or special methods of doing this, we will keep this price at 20 cents apiece, and assume that as the price of these articles, allow you to make as many as you can, and divide the honors with you." Then the company would be getting its pay for making the special tools by retaining 50 per cent of the increase, and the man the other 50 per cent of increase over his day rate. Of course, that continued indefinitely would be rather difficult to keep up in the accounts, but if it is continued probably six months, the man would give it a fair trial, would be anxious to make all he could, and every time he made over the regular day rate amount he would get one-half of it, and the company would be getting special tools, that in the long run would establish the price. At the same time, it would have the advantage of getting the men interested at the start, because if a man were able to make ten on every working day, even if he made only the same amount, he would be getting no less money than heretofore, and yet any increase in the output would benefit both him and the company. The company, of course, would supply any tools or whatever necessary appliances were needed for the work. If this was continued for a short time only, human nature would be apt to take it easy while the price was being established, but if this were continued for six months, it seems to me that self-interest would naturally induce the man to turn out as many as possible, for the mutual benefit of the company and himself. I offer this as a suggestion, as I have not given it very much thought, but I would like to hear from others who have gone into the piece work and learn how it can best be done and make it fair to the men.

I recognize it is of the utmost importance to have a perfectly

clear understanding with the men, taking them into your confidence and explaining to them, so that there will be no danger of anybody being frightened and think that they are being imposed upon; and I think, if we act fair and square, we will find it is to our mutual advantage for the men to make a little more money. After the price is established, it certainly is, to say the least, not strictly honorable to cut it. If the man is taken into confidence, and has worked up a better device, and has been given to understand that he would be allowed to make such a rate, the price should not be cut down because we think he ought not to make so much money. I think such practice as that does more harm than anything else, and I think good faith should be kept with the men.

Mr. W. S. Morris (Chesapeake & Ohio R. R.): Mr. Chairman, I have listened to the gentlemen very attentively, and, while I can not offer anything particularly new on this subject, I believe that circumstances and conditions must govern both sides of the question.

In the Newport News shipyard, which is adjacent to our property (you have all seen it, probably, when at the M. C. B. convention— the Newport News Ship Building & Dry Dock Co.), about one-third of their men are working piece work, but the greater number of the men are on day work. It is a very extensive manufacturing concern. All the repairs to vessels that come to the dock are done on day work. There is no piece work when repair work is entertained.

I think that, where there is much new work, piece work can be established with considerable economy to any concern and some better earnings to the men. The trouble has been that the stint has not been correct in a great many cases, and occasioned a great deal of dissatisfaction among the men where piece work has been introduced. We, of course, have all got to establish our prices on piece work according to the circumstances that are dependent upon our conveniences.

In the shops of the Chesapeake & Ohio, we work day work all through. We have been a little timid about starting piece work. We have a system of check that goes to the foreman in the way of an operation card, on which each workman defines his work, and it is handed to the foreman by the workman. Understand, this is on repair work, for we do very little new work. The cards are consolidated when the machine or car is turned out, and the labor, with the storeroom cost, shows absolutely the cost of each item or piece in

that machine or car, whatever it may be. We find there is a great variation, so much so that we are timid about starting piece work prices on repairs. For example, a rocker box to be treated may take considerable more time in one engine than it will in another.

Now, I think there is a great deal to be said for day work in this way: The men invariably like it, and, as Mr. Miller remarked, the introduction of new machines is a good thing to help the output, working under either system.

I am satisfied that, if we introduced piece work into our shops, we would necessarily have to employ more clerical help. We have introduced a new machine, however, that seems to substantiate the point that we are doing very well. Last year we paid a dividend, the first in the history of the C. & O., all men working day work. Our men are contented, and we think the conditions and circumstances with us do not warrant the introduction of piece work at the present time.

THE CHAIRMAN: We have with us a gentleman that gets around the country considerably, and sees a great deal that is going on, and has pretty decided views of his own as to how things should be done. I should like to hear from Mr. Sinclair.

MR. ANGUS SINCLAIR (Editor *Locomotive Engineering*): I have taken a great deal of interest in piece work, in railroad shops especially, and in manufacturing establishments, and I have a sort of a mixed feeling in regard to it. I think it is admirably adapted to establishments where there is constant reproduction of work; where a man is continually performing the same species of service. But my experience with repair work of all kinds inclines me to think that piece work is not well adapted to that. If all workmen were fair, and if all employers were inclined to be fair and honest and righteous to their employes, and the employes the same to their employers, I think paying for results would be the ideal way of men getting paid for their work. It would give the skillful quick man the benefit of his skill and rapidity; it would stimulate the slow man so that he would try and do a little better; but my experience of piece work in railroad shops, extending over about twenty years, is that when men become skillful enough to make very much more than the ordinary day's wages, the rates are cut, and that demoralizes the whole system. It not only demoralizes those immediately concerned, but those in the neighborhood, and where men go from one place to another. If men

have been earning what was considerably above day wages at piece work, and are cut down and cut down till they are nearly at the ordinary day wages by working exceedingly hard, it spreads around among all the shops,—you may say all the shops in the country. There is a particularly strong sentiment, on the whole, among mechanics against piece work, and I think that the practice of employers is responsible for it. There are many employers who do not follow the practice of cutting down prices, but the few who do, demoralize the whole business.

There is another thing about piece work that we hear very little about. The people in charge will say, "Now we are going to introduce piece work into this shop," and they figure around on what it costs for certain operations, probably turning out a pair of driving wheels, turning out an axle, fitting out a set of links, or something of that sort, and they will say, "Now, we will start out on that basis, at the rate of the cost originally of doing that work at day rates," and in some shops it is just simply amazing, the increase in the work the men will turn out when they are changed to piece work, while in other shops they make little more than they did working by the day. Now where is the explanation of that mystery? All will agree that something is wrong, and we want to have it explained. As far as I can see, the explanation is that in one place there has been an efficient foreman, who understood his business and knew that the men were doing the proper amount of work with the tools, or in fitting; and in the other the foreman was incompetent, not being certain from his own personal knowledge just how much work a mechanic ought to finish in a given time. With the latter kind of a foreman, some of the men would take the world easy, and would not exert themselves to do a fair day's work; yet the uninitiated say that it is the piece work which makes the difference in the output of the two shops. Before a master mechanic begins to complain that the output of a shop is too small, and that they must try and experiment with piece work, he ought to find out just exactly what kind of a foreman he has managing the business.

THE CHAIRMAN: We have a good deal of business yet before us, and I will ask the gentlemen who continue this discussion to make their remarks as brief and pointed as possible, but I would like to hear from somebody in the repair yards and roundhouses on the subject of piece work. I understand there are a number of yards and

roundhouses that are working piece work, and I think it would be for the interest of the meeting to hear from some of those gentlemen. I am unable to call their names ; I wish they would volunteer their remarks.

Mr. F. A. Chase (H. & St. J. R. R.) : I do not feel that I am prepared to say very much on this subject, although I have felt interested in the question of piece work for a number of years. When I was quite a young man, working in the east, I did considerable work by piece work, and I felt very much interested in it, and thought it was really the best way, not only for the company but for the men, and this was almost wholly on new work.

Something like four years ago I commenced in a small way on the lines where I am located, to work at piece work on freight car repairs, and it seemed to be a very hard problem. I could not devise any way that we could work piece work on repairs of freight cars or engines and make a price equitable to the company and the men, on account of the work on one engine, or one car at one time, taking almost double as long as it would on another car or an engine at another time, but we averaged the prices, went slowly, and got along quite well. Finally, I thought it would be better to tackle one of the worst jobs I think there is on a railroad to do by piece work, and that was running repairs on locomotives in a roundhouse. We started in, in a small way, as we did when we commenced working on freight car repairs, and it took a great deal of figuring and very close observation of everything that was done, to set the price so that we thought it would be very near what we would want to use in starting in ; we experienced considerable trouble, that is, we had to change prices from time to time. What we aimed to do first was, to be sure that we set the prices low enough, so that instead of cutting them down, we would want to raise them, because we realized that where prices were once set and they were afterward cut down, it discouraged the men.

Another thing we took into consideration was, that we could not set these prices and carry them out without consulting to a certain extent with the men ; and there was one quite vital point in doing the work, namely, to have the men understand that they were a party to the contract. For instance, if we found that a price appeared to be too high or too low, we talked the matter over with the men that were doing that kind of work, and had an understanding with them

to that effect, so that they were satisfied, as well as we, that the price was too high or too low, and we mutually agreed that the prices were not right, and a change would be made. We went along in that way, and the men, as a whole, have been quite well satisfied.

We are not doing all, but most all, of the running repairs on the locomotives in three different roundhouses, where we handle from nine to twelve hundred engines a month. We have a good many old engines that were built a number of years ago, which, of course, are different from the later build, and it takes considerable time to get the prices set for doing the work on the different classes of engines—that is, doing the same job. Probably, in some cases, we are doing from 60 to 80 per cent of all the repairs, while in others probably not over from 30 to 40 per cent.

We found there is one thing that makes it a little more expensive, and that is in the supervision and clerical work; but we feel that we are amply paid for that. In starting in, in each case we have an understanding with the men to the effect that the prices that are set are for doing first-class work; that we will not accept any work done unless it is first class, as good as they have ever done when they worked by the hour. Of course, at first we experienced more or less trouble with some of the men that were in the habit of slighting their work; but when they found that we would not put up with that, that if they slighted the work they would have to do it over again, it made a different state of affairs, and they did better.

Now, in regard to doing the work well: For instance, after a year has passed, where we would give a locomotive what you would call general repairs, as a rule, we would run that engine out in the yard, or back and forth on the line a short distance—what we would call "breaking it in." As a rule, it would take about two days before the engine was in proper shape to put out on the train—that is, on a slow way freight train. The same thing has existed since we have commenced to work piece work, and I have noticed it more particularly within the last six or eight months. We have sent several engines out of the shop that we have only run one day instead of two, and put them out on the road on a slow freight train, way freight, and they have not given us any particular trouble. I do not know why they have not done just as well as engines where we have been two days in breaking them in. That leads me to believe, on general

principles, that our men must be doing as good work by piece work as they were by the hour.

We have found that in a good many cases some of the foremen or assistant foremen have not — that is, we felt that they have not — been looking after different operations as closely as they should. When we come to piece work, for instance, one of the things that has given us more thought and more trouble, in some cases, is to get material and to get stock on hand ready for the men. Instead of the foreman being obliged to watch the men so very closely to see that they work and have tools and material, it is the other way; the men are watching the foreman and the assistant foreman to see that they do get material and tools, and that the work is ready for them.

Another thing; we find that the foremen have to be more alert, more watchful in every way to keep the men at work. When they are at work by the hour, it does not make much difference to the men. If they finish a job at 4 or 4:30 p.m., they do not do any great hustling to get another one until the next morning. When they are at work on the piece work system, they are right after the foreman to get another job before they get through with the one they are on. We think there is a benefit in a great many ways and, so far, where we have experienced more or less trouble one way and the other, we find that everybody connected with piece work has become more watchful and careful than formerly. In the end, we feel that it is a success and is really a benefit to the company as well as to the men. Where a man makes quite a little more than he did by the hour rate, some men almost double what they were making; others do not make as much. When we get the prices set so we think they are about right, we do not change them. Let a man make whatever he can.

For instance, in regard to what men make, we had a man in one shop that was doing a certain kind of work. It was a vise job, where it depended on his own exertions fully; in some months, one month in particular, he made 38 cents an hour; other months he would run along about 30 cents and a little over. We started piece work in one of the other shops, where we had a man that was about the same age as this one I mentioned, who did the identical work, under the same conditions, but that man only made 16 cents an hour. He kept on with the work perhaps for a couple of weeks, and then he wanted the prices raised; but when he was told that the other man

was doing the same work and was making 30 cents an hour, he did not say much, and we did not change the prices.

The Chairman: You say from 40 to 60 per cent of your repair work is done by piece work. Do you divide a day, and work a man part of the day on piece work and part on day work?

Mr. Chase: No; we did that to a certain extent when we first started in, only for a very short time, because we did not have prices; we were only performing a small number of operations, but at present we aim to keep what men we have at work on piece work at work all day. If we commence in the morning we aim to keep them all day on piece work; we do not divide the day by working part of the time piece work and part of the time by the hour.

Mr. F. A. Delano (C., B. & Q. R. R.): There is one thing I would like to allude to. One of the speakers here rather took the position, as I gather from his remarks, that piece work is unfair. Now most of us in this room would not want, I think, to favor anything which is unfair in principle, and it is well to consider the principles involved a little bit.

Mr. Sinclair has gone so far as to say that he considers that the piece work, if it is run in the proper way and in the ideal way, is the ideal system. Now there are those of course, I will concede, who will have their own opinions as to what work is adapted to piece work and what is not. They are entitled to their individual opinions, but let us consider the principles. The man who manufactures cloth, we will say, sells his cloth by the yard or by the piece, and it is the same way in any other manufacturing business. Now, if it is right for the manufacturer to sell by the piece what he produces, is it not right that he should turn around and pay the men, who are engaged in that manufacture, by the piece, they sharing with him, and so becoming partners in the work of producing?

Another thing that has been touched upon is that laboring men, mechanics, etc., are opposed to piece work. I know that that is so to some extent, and it is especially so before they have tried it; but I am happy to say that in some large shops, where it has been tried, they are very much in favor of it, and in some cases are pushing the master mechanics to adopt piece work in operations where it has not been put in.

Let us consider why they are opposed to it at the start. One reason has been touched on, and that is, that they are suspicious;

they are suspicious of any new method, and they are suspicious that they are going to be unfairly dealt with, that the prices of piece work are going to be reduced after having been once fixed ; but it is also well to take cognizance of the fact that laboring men frequently look at the question of compensation in an entirely opposite way from many employers. The day work system contemplates paying every man the same rate for a day's work, every machinist gets the same amount, which is called "standard pay." Now every employer knows, every foreman knows, and for that matter, every mechanic, that every machinist has not equal ability. Now is it right, is it just, that men should be paid the same rate for an unequal amount of work? The laboring man thinks it is, and the Building Trades Unions in Chicago, as all of you know from the papers, have gone to the extreme stand that a plumber, a mason, a plasterer, a carpenter, a bricklayer, may do a certain amount of work for a day's work and no more, and that the measure of that work is what the least skillful man can do, and the best man is not allowed to do a bit more than that. If *that* is justice, then the *piece work* system is *not* justice, but I conceive that to pay a man honestly and fairly for what he actually does is justice.

MR. E. E. RUSSELL TRATMAN : I am particularly glad that some of the speakers have referred to the importance of treating the men not merely with fairness but also with confidence, and on the basis of mutual interest, because at this time there is such an unfortunate tendency toward hostility between employers and employes. Each side is too apt to look at its own interests merely, and to regard the employes as mere machines, or the employers as mere paymasters with unlimited capacity. If the piece-rating or piece work system will check this tendency and establish a better relation as of man to man, this will be one of its most important effects. Mr. Sinclair thinks that a competent foreman would be a remedy for many of the defects of the day work system, but it must be remembered that under this system the men have to be driven more or less, as is inevitable and natural, while under the piece work system each man is his own driver. This is pleasanter for the man and more satisfactory in regard to the capacity of output of the plant. In regard to comparisons with English conditions, the engineers' or machinists' unions have had great power and have arbitrarily restricted the output and the capacity, much as is done in the plumbing and other trades today

in Chicago. Under these conditions, the manufacturers had little inducement to put in new and improved machinery. Since the great strike of a year or two ago, there have probably been important changes in this respect in England.

Mr. Miller: If I may be permitted, there are two or three questions that suggested themselves to me in this discussion. It is expected that the employer will have material on hand at all times, so that when one job is finished, there will be material on hand for the next. Supposing they fail to do that, who pays the man for the loss of time? Again, supposing the man spoils a piece of work, who supplies the material, who pays for that material?

Again, on page 2, in day work, it speaks of keeping the tools in order, which I consider has no place in the workshop. Who keeps the machines and tools in order in piece work?

Mr. R. T. Shea (H. & St. J. R. R.): Mr. Chairman, some of the members seem to think that all the ills the shops are heir to are due to piece work. Now, as far as doing poor work is concerned, it does not make any difference whether a man is doing piece work or day work; it simply resolves itself into the question of compensating the man for labor performed: If he did poor work when paid by the day, he will probably do poor work when paid by the piece. The quality of the work has nothing to do with piece pay, but is governed by the supervision.

We find that men, as a rule, do better work by piece work than day work, because, if their piece work is not first class, it won't be accepted, and they have to do it over for nothing. If a man takes a contract for a certain amount of work at a given price, it is presumed that he will do it right. If he does not, we will not pay the price.

Mr. Miller says that the prices he examined were too high. That is possible. He may have tested prices based on a $3.00 man with poor facilities, against a $2.00 man with first-class facilities. The only successful way to get prices is to base them on your conditions and facilities. I know of three different shops on the same line of road, under the same management, that pay a different price in each shop for the same operation. We would make a great mistake if we got prices from San Francisco, say, based on a $3.00 man, and attempt to adopt their scale, when our day rates are, say, $1.50. Some one has said that paying enginemen and shopmen are two different propositions. I claim that they are not, as it simply resolves

itself into work performed. In one case, a man hauls a given load from one point to another; in the other case, a man builds the engine. If you can pay the engineer so much for going from one point to another, why not the shopman so many dollars for building the engine?

We are supposed to have material on hand for the men to use; and if we have not, it is poor supervision. If a man reports at the shop in the morning, he is supposed to work all day; and if he has to stand around and wait for material or work, he should be paid for the time he loses and the foreman held accountable. If men spoil work, it is their loss, and the company loses the material; but we never have any trouble on that score. Men can not afford to spoil work, for several reasons. I have heard of cases where men have spoiled material, working by the day, and the company stood all the loss. This is largely a matter of supervision. Keeping tools in order is merely shop supervision, and should be handled the same under piece work as under day work, except that the men will demand better tools, as they can't afford to work with poor ones.

The question of poor work is no argument either for or against piece work.

In regard to the 50 per cent division, as suggested by Mr. Henderson, on the increase made by devising new methods, I would want to think this over carefully before giving an opinion, and would want to go slow, as we might establish a custom that would not suit all conditions. His other method of cutting out all useless operations is one of the best things I have heard advanced, and seems to be fair, both to the men and to the company; but my experience is that you can not establish any fixed rule for setting prices.

The Chairman: We have a couple of reports that we will listen to before recess.

The Secretary then read the report of the committee appointed in regard to extending an invitation to the International Railway Congress to hold its meeting in the United States in 1904.

Chicago, November 21, 1899.

To the Western Railway Club:

Your committee, appointed at the last meeting to carry out the wishes of the Club in joining like organizations in efforts to secure an invitation from the United States Congress to the International Railway Congress to hold its meeting in 1904 in the United States, begs leave to suggest to the Club the adoption of the following resolution:

Resolved, That the New York Railway Club be requested to have the necessary congressional resolution prepared, and to secure some senator or member of the House of Representatives to agree to offer the same at the coming session of Congress; that copies of said resolution be printed and sent to the various railway clubs and organizations in the United States, with the request that they hand the same to their representative members of Congress, and use their influence to secure the support of the resolution. And it is further

Resolved, That the Western Railway Club offer to bear its reasonable proportion of the expenses of such action.

Respectfully submitted,

WILLARD A. SMITH, Chairman.
H. P. ROBINSON,
J. H. McCONNELL,
F. A. DELANO,
PROF. WM. F. M. GOSS.

On motion of Mr. Peck, the resolution was adopted.

THE CHAIRMAN: We have a Committee on Smoke Nuisance, from which we would like to hear.

MR. HENDERSON: I believe the committee was appointed to report at some subsequent meeting, but this is almost too subsequent. However, the committee has got the work under way, and can merely report progress now. We hope in a short time to have quite a mass of useful information.

THE CHAIRMAN: If those who have not done so, will register in the little box at the rear of the hall, their names will then appear in the Proceedings. If there are any who have not paid their dues for this year, the Secretary will entertain them at the cost of $2.00.

RECESS.

THE CHAIRMAN: The second paper for the day is one on the "Pooling of Locomotives," by Mr. M. E. Wells, as follows:

Pooling of Locomotives

By M. E. Wells

There being, at the present time, considerable discussion for and against the pooling of locomotives, and having had some experience running engines in what seems to me to be a very successful pooling arrangement, I wish to add what I can in favor of that system.

Men, engines and conditions are very similar the country over ; and I feel sure pooling could be made just as much of a success in one place as in another, providing always that all who have anything to do with it, take hold to make it such. Long continued practices are difficult to change, and, because engineers have run regular engines for so many years, it seems to them, at first glance, that pooling cannot be successful.

Men must have regular rest, while engines need only repairs. Is there any argument why a locomotive should lie in the roundhouse longer than is necessary to make these repairs ? The arguments are rather on the other side, for, if the boiler does not need washing, it is an actual detriment for it to cool down. We have, all around us, examples of almost continuous service of other classes of engines. Why are locomotives any exception to this rule ? What would the world have thought had the engineers of the battleship "Oregon" insisted that their engines needed rest, on its trip of a year ago ? They needed no rest and, from all reports, very few repairs. And what was most gratifying was that, on the completion of the longest and most celebrated run ever made by any steam craft, the ship joined the South Atlantic squadron, was reported O.K. and ready for immediate service ; and when action came, she again demonstrated the efficiency of her engines, as well as her guns. Another case I am familiar with is the hoisting and mill engines of the celebrated Homestake mines at Lead City, S. Dak. The mill engines run continuously, and only have steam shut off every fifteen days, when they are stopped for a few hours in order that the gold may be cleaned off the plates in the mill. The large hoisting engines consist of a pair of simple engines coupled, with the usual link-reversing gear, and the work they do corresponds almost exactly to the work a switch engine does—going ahead and backing up at intervals. These engines run continuously, except at very long intervals, when repairs are needed. Each engine is manned by three engineers, each working 8-hour shifts.

The pool with which I am familiar includes both freight and passenger runs, and is by no means an experiment, having been in successful operation since August, 1893. In it there are used 8-wheel, 10-wheel, mogul and consolidated locomotives. There are also fast trains, slow trains, work and local trains, and all these runs are pooled, the crews being run first in, first out, while the engines are put on the different trains to the best advantage to the company. There are fifty-two crews, forty-one being in the freight pool and eleven in the passenger pool. To keep these crews going requires an average of thirty-seven engines, thirty being used in freight service and seven in passenger service. But if necessity demands it, the engines of one pool are used in the other. Here will be noted

a saving of fifteen engines over the old system of regular engines, and, counting the average value of an engine at $10,000, makes a saving of $150,000 in the amount invested in machinery.

In the pool, as we have it, each engine is equipped with headlight and signal oil cans, and the necessary tools in locked boxes, the keys being kept on a large board in the foreman's office. All that an engineer transfers from one engine to another is an oiler, a supply can for engine oil, a tallow pot and a torch, all these being marked with his number. The crew is called about an hour and a half before time to leave the roundhouse. When called, they know what train they get, and where they go ; but the engine they are to have they only learn on reaching the foreman's office, where they receive the keys to the boxes. The engineer goes at once to the oil house, gets his cans, goes directly to the engine, and proceeds to fill all cups, and oils and inspects the engine. While the engineer is thus engaged, the fireman is lighting the lights, if at night; filling the lubricator, getting the signals ready, if any are to be carried, and wiping the windows and the inside of the cab.

On coming in, while the engineer is looking the engine over for his work report, the fireman is filling the headlight, cab and signal lights. The three cans and the torch, previously described, are turned in at the oil house, and the crew goes home and stays there until called again. This is the simple statement of the working of our pool. I will now take up more specifically some of the methods followed in the different branches, beginning with what is, to my mind, the best point in the system, viz., the engine inspection.

An engineer comes into a division point and puts his engine on the clinker pit track. Before turning it over to the hostler, he goes over it carefully, examines all bearings, and inspects it as thoroughly as can be done by getting around on the outside, and reports all work that he finds to be done. The engine is coaled, sanded, the tank filled, the fire knocked, and then placed in the roundhouse. While in the roundhouse, over a pit, an inspector goes over this engine carefully and thoroughly. While this is being done, the boilermakers are inspecting the boiler, flues, grates, ash pan and front end. The man who regularly packs truck and driving boxes, looks over all packing to see that it is not settling away from the journals. The time he now spends in watching the packing and keeping it in shape, he used to spend in packing hot boxes ; but it is much pleasanter for him, and more profitable for the company, to keep the packing in good shape than it is to pack the hot boxes. And all this advantage is reaped with a reduction in the cost ; for while the wages of the truck packer remain the same, the company is saving oil, and, what is a greater advantage, saving delays on the road. An official report for August, 1899, showing an engine mileage of 299,205 miles, has but two engine delays from hot boxes—one of twenty-three minutes for a hot driving box, and one of thirty minutes for a hot engine truck.

But to return to our inspection. When all work reported is done, the engine is ready for another trip. Let me say here that the engines are always placed in the roundhouse, over a pit, for the inspectors. No amount of "hurry up" from the dispatcher varies the rule. The most economical place for an engine to die or break down is in the roundhouse (it is expensive when it happens on the road), and a little wait for an engine is better than an engine failure on the road. I do

not intend to criticise the engineer's inspection under the old system ; but his inspection is usually made when the engine is covered with dust and oil in summer and with ice in winter, and he could not be expected to find a great many defects that could be more readily found when the engine is in the roundhouse and cleaned. I have said that engines and conditions are very similar the country over, and I think you will agree with me that human nature is pretty much the same wherever you find it. Engineers are run very hard sometimes, in rushes of business, both in the pool and out of it ; and when an engineer has been on his engine for eighteen, twenty, and sometimes twenty-four hours without rest, is he, gentlemen, in all reason, competent to do a good job of inspection ? In rushes of business, he cannot go to the roundhouse for his more careful inspection, for the caller is after him before he has had the rest that he should have, and he goes down and goes out, often on a "hurry up" order, when something about his engine is not as it should be. This is but a plain statement of facts, and is not given here as a criticism, but rather in vindication of the too often overworked man at the throttle.

But no matter how thorough any one inspection may be, three inspections are better than one. Another point worthy of consideration is that the engine stands in two different positions under the three separate inspections, and what might be hidden by counterbalances and other moving parts, in one position, would more than likely be exposed in the other. The incoming engineer is made to be careful in his inspection ; for if the roundhouse inspector finds anything that the engineer should have found, the latter is checked up on it. The engineer who goes out on this engine also inspects it ; and if he finds anything not O.K., both the incoming engineer and the inspector are checked. I can give you a good idea of the efficiency of the roundhouse inspector's work by enumerating some of the defects he is continually finding that would result in serious break-downs on the road : Cracked driving and side rods, eccentric cams, straps and blades, transmitting blades, wheels, rod straps and frames. This is about as thorough an inspection as it is possible to give an engine between trips ; and in refutation of the argument that an engineer can inspect his engine better than anyone else, the result here is a great decrease in break-downs and engine failures, arguing conclusively for the system of inspection followed by this pool. The same official report, previously quoted, shows but five other engine delays for the month of August, 1899, none of which could be traced to poor inspection. They are as follows :

One delay for engine not steaming;
One delay for broken spring hanger;
One delay for broken valve stem;
One delay for injector not working;
One delay for failure of air pump.

The entire report shows but these seven engine delays for 299,205 engine miles, or one delay for every 42,743 engine miles ; while the best showing for the same month, on a non-pooled division, was 16,472 engine miles to one delay. This, in my opinion, can be credited to nothing but the careful system of inspection carried on under the pool.

I wish to speak briefly of the manner in which the oil and coal records are kept. At all division points the engineer's cans and torch are turned in and cared

for. At the home division, the man in charge of the oil house receives and cares for them, filling them, and in winter with warm tallow and oil. When the engineer gets his cans, he makes a ticket for just what oil it took to fill them. The tallow pot holds four pints, and the engine oil supply can holds five. If the latter contained three pints when he turned it in, he makes a ticket for the two pints it takes to fill it. In this way an accurate account is kept of the oil each man uses. Of course, if care is not taken to only put in the lubricator just what oil is needed on the run to be made, it becomes necessary to drain the lubricator, or else give the man who follows you that amount of tallow. With a little experience, just the right amount can be put in.

To keep an account of the coal consumption by each engine crew, the tanks are filled to a uniform height. An engineer receives the engine with a full tank of coal; and when he leaves it, he makes a ticket in blank; the hostler fills the tank to the regulation height, and fills in the ticket with the amount it takes.

Under the pool system, the fireman does not go to the roundhouse and put in three or four hours cleaning his engine, nor does the engineer go down and pack the throttle and cab glands, clean the headlight, put in lubricator glasses, or do the numberless little things that he used to do under the old system of regular engines.

I can remember the time when it was thought that only certain men could run the fast and important trains, but the pool has exploded all this. It has been thoroughly demonstrated that it is the engine, and not so much the man, that gets an important train through on time. The important question with us is, What engine goes on this run? not what crew. Any of the pool crews takes the train through on time with a good engine. Under the old system of regular engines, the younger runners must, of course, take the poorer engines; and if, by force of circumstances, they catch an important run and fail, it usually goes hard with them. They are sometimes pulled off and set back, and many an injustice has been done young runners in this way, when probably the oldest runner on the line would have made as great a failure under the same conditions. The idea that only certain men could be trusted with important trains, grew out of just such circumstances as these.

With us, we have an extra passenger list, consisting of the oldest runners on freight, and at the home division point they are given the preference on extra passenger runs; but at all division points away from home, the pool crews take their turns as it happens on such runs.

All roads have the different types of engines, and the 8-wheel engines are not much in demand, except during rushes of business; and before the pool arrangement, the men assigned to the small engines in dull times would make very little, compared to the men on the larger engines; but this is now equalized.

In arguments against the pool system, a great deal of stress is placed on the assertion of great increase in roundhouse work and running repairs. A little analysis, in detail, of this subject shows that the increase in expense is not so very great. Take, for example, the cleaning of headlights. In the pool I have described, there are thirty-seven engines. A man can clean a headlight easily in thirty minutes. To clean the thirty-seven would require eighteen and a half hours; and if they are cleaned every two weeks, here would be thirty-seven hours per

month it would cost to clean headlights. The packing of throttle stem and cab glands and the putting in of water and lubricator glasses is done by the machinists and their helpers, and it is hard to discover that there is any additional expense in this line. Of course, the salary of the engine inspector is extra, but our decrease in engine delays and failures on the road is worth many times this expense to the company. So, looking at it from almost any standpoint, there is not much but advantage.

In the matter of oii records, the division where the pool is in operation makes a showing for August, 1899, of 70.02 miles per pint of valve oil, as against an average of 74.3 miles per pint of valve oil on three other divisions where the pool is not in operation. On engine oil it is 67.25 against 63.89 ; in one case the showing being against, and in the other in favor of, the pool. What I wish especially to show is that there is no great difference either way, and that there is no argument against the pool in these figures.

In the matter of coal, the showing is in favor of the pool :

	Pounds of Coal per 100 Ton-Miles. Freight.	Passenger.
Pool division	20.70	29.80
Regular engines	24.00	33.00

Engine crews make about three thousand five hundred miles per month, and, of course, with regular engines, the engines would make about this mileage. Here are figures showing the mileage made by some pool engines in one month : 7,688, 7,228, 7,316, 6,014, 5,648, 5,702. I wish to speak especially of the mileage recently made by a passenger engine in one month, and this record is being kept up from month to month as a steady work. This engine doubles a division, making 333 miles per day. This it did for twenty consecutive days, when it lost one trip for repairs, and then went back on the run for the rest of the month. This shows a mileage for this engine during the month of 9,657 miles.

The Chairman : I believe Mr. Wells is present in the room. Is there anything you would like to say before the opening of the discussion on the paper?

Mr. M. E. Wells (B. & M. R. R. R.) : Mr. Chairman, and gentlemen of the Western Railway Club : I do not want to say very much; I want you to do the talking. In opening this discussion, I first wish to make a correction in figures. At the bottom of page 14, referring to miles run to one engine delay, it should read : "The entire report shows but these seven engine delays for 218,526 engine miles, or one delay for every 31,218 engine miles." The corrections do not change the showing. The first figures included switch engine mileage, which should have been deducted. In this connection I

will say that I have with me figures for other months that make the same showing in favor of the pool as the August figures.

Another point: If other classes of engines run continuously, or nearly so, why not locomotives? If locomotives cannot be run continuously, run them as continuously as you can. An engineer makes a day's wages in four and five hours nowadays; why should his engine stand in the roundhouse nineteen and twenty hours, waiting until he is ready to make another day's pay in the same four or five hours? Here are some advantages to the crews:

1. In being able to take rest regardless of whether the company needs the continued services of the engine.

2. In not having to do cleaning and other work at the roundhouse between trips. This latter makes it possible for the crews to spend more time with their families, or improving their minds by reading.

3. In not being held in while their engines are being overhauled, or while work is being done on them.

4. In dividing the work up better between all the crews, it accomplishes what all governments are organized for, "The greatest good for the greatest number."

5. While it is pleasanter, perhaps, to run a regular engine, it is very expensive for the company to furnish each engineer with a regular engine. They cost about $10,000 apiece. I say while it is pleasanter; I wish also to say from personal experience that it is not as unpleasant running pooled engines as is argued.

Some advantages to the railroad company, are as follows:

1. In making thirty-seven locomotives do the work it formerly took fifty-two to do.

2. In being able to use its locomotives to the best advantage regardless of whether a crew needs rest or not.

3. In a reduction of engine delays due to the system of inspection described in my paper.

4. In being able to get greatest possible mileage out of an engine between overhaulings.

I wish to read what President McBain, of the Traveling Engineers' Association, has said, on long runs of locomotives, which means practically the same thing as pooling. He says:

"I would suggest that, in discussing this question, we go into the matter with a view of overcoming any little difficulty that may beset

the plan, rather than with the idea that it is not as good as the old arrangement. If the gentlemen at the head of our corporations determine that it is to the commercial advantage of their companies to make long runs with locomotives, we, as practical men in the business, must go at the thing right; that is, with the determination to surmount any difficulty we may encounter. If we do this, it will be surprising to us how little the objections to the plan really are." This is entirely commendable, and looks at the matter of pooling in the right way.

Another thing I would like to speak about, is that the adjustable parts of a locomotive are growing less and less all the time. We now have solid wedges and, as a consequence, do not have wedges to set up. There are no keys in the side rod brasses any more, and in the last month I have run an engine a couple of trips that had solid back end main rod brasses, and I have been very much impressed with the smoothness with which it runs. Of course, I have no conclusions to give regarding solid back end brasses. I think these solid back ends have been running since February, 1899, and if they have, making the mileage the pool engines make, I see no reason for not adopting solid back ends. This is, however, getting away from the point at issue.

I would like to add, before closing, a few thoughts in regard to the adoption of the pool. The pooling of locomotives, like a great many other good things in this world, can be made to appear a very bad thing if it is not slowly and carefully installed.

Some roads have suddenly found themselves very short of power, and have as suddenly resorted to the pooling of locomotives without any very definite idea as to how it was to be done. It is needless to say that such attempts could not be expected to be successful.

Superintendent Gordan, of the Lincoln, Neb., public schools, in a meeting that I attended not long ago, spoke of the Spier method of teaching some particular branch in the schools. He said: "The Spier method is a splendid good thing when taken in moderation. The trouble with the Spier method, as applied to the Lincoln schools, was that the children were given too large a dose to start with." They were not prepared for the sudden change; they were given more than they could digest, and the result was nausea. This is also true of the pooling of locomotives, and of the piece work method

in shops. These things must be gone at in the right way; and when they are, the results are, as a rule, very satisfactory.

The Chairman: Gentlemen, I hope you will take hold of this paper just as vigorously as you did the one on piece work. Do not wait to be called on, but keep the ball rolling. Mr. Conger, suppose we hear from you on this subject. I understand you are a little enthusiastic on this question.

Mr. C. B. Conger (*Locomotive Engineering*): Most of my experience with pooling has been in what you might call the chain gang system.

Just as soon as one man brought in an engine and it was wanted on another train, they took it away from him and put another man on it, and away it went. When he was ready to go out, he took another engine. The engines were repaired when it was actually necessary to do so. Sometimes the trains were waiting in the yard before the engine came in, so they were held as short a time as possible. Now, in a case of that kind, where the power is so short, we can hardly say that the pooling system would get a fair show, because there was not any regular system about it.

The inspection of engines, when they came in and before they went out, was very limited. The men had been long hours on the road; they did not care very much whether they were back or not. They did not inspect as closely as they should, and there were no other inspectors except the engineers who ran the engines. In such a case, you can readily understand that the power would run down, and, what is of a great deal more value to the locomotive department than the power run down, or what affects the revenues of the company more, the spirits of the men ran down so they did not care whether the engines were kept up or not, if they would only run along.

I believe the pooling system can be systematized, but you must commence at the right place — commence at the shop organization; provide inspectors and mechanics to get the engines ready to go out, so that when the engine crews take them they will be in good order and do the work properly. A complete pooling system should take in the engineer and fireman last thing. Ordinarily, it takes them in first thing, makes them do the work of the mechanics and inspectors, and be the responsible parties of the whole operation. I do not see how such a pooling system can be a success.

I take issue with my friend on one matter, in which he says that the pooling system has demonstrated the fact that it is the engine, and not so much the man, that gets an important train through on time. Not only my experience, but my observation, is directly against this. You can make the engine all right, but you can not make the men all alike ; some are better than others. In that I take issue with Mr. Wells.

At the top of page 15 he speaks of supplying the engine with oil. I think the oil that remains in a man's can should be weighed, and the oil that that man takes out should go through the same process. Ounces are a good deal easier handled than parts of pints, and a man can not complain that his can did not hold a pint, while they charged him with a pint. A man may claim that he brought in oil and did not get credit for it. I think a pair of scales would do away with that. But, above all, what you might call the "loyal spirit" of the man has got to be cultivated as much as the engine that has got to be repaired, if the pooling system is a success.

Mr. Henderson : I merely wanted to speak for a moment in regard to weighing the oil that Mr. Conger has touched upon. I think that is a move in the right direction, and I thought I would describe a process, or an apparatus, which we got up on the Norfolk & Western road. I do not think it was put in force as thoroughly as we intended. We took an ordinary platform scale that was arranged with a dial, instead of having a spring balance. This was arranged with a dial, like a steam gauge, so that it would show the weight that was on the scales. We fitted a disc to this, which was graduated the same as the original dial, but it could be moved around by means of a couple of knobs. We had suitable oil cans provided ; and when the engineer came in from the trip, the can was turned in to the man that was in charge of the oil house. These cans were delivered to the engineer full up to the neck when he went out. They were of a certain capacity, which was considered proper for a run, and they were full when delivered to the men. When they came in, the cans were put on the scale. We did not have to weigh the cans, nor the amount of oil that was in them, but we merely twisted the dial until the zero on the dial stood opposite the needle, no matter where the needle stood ; and then the can was filled up and the weight of the increase taken, showing the amount of oil added to fill up the can, and that was the amount the men would be charged for on the run that had

just been completed. In that way, there was no difficulty in keeping account of the oil that was used, and there was no mathematical calculation, subtraction or anything of that sort made by the man in the oil house. It was done mechanically. We simply filled up the can, then read from the dial, and, of course, it was known that that was the amount of oil used in the trip, so that the exact number of ounces could be ascertained.

Mr. J. F. Deems: Either Mr. Conger or I have not read this paper correctly. My impression is that Mr. Conger has the idea one man comes in with the oil can and another man takes it out. The paper does not say so. The idea is that each man has his special oil can, and that remains with the man and not with the engine; hence, there would not be any question between two men. There might still be the necessity of weighing the oil, as mentioned by Mr. Henderson, in order to keep track of the particular man.

Mr. Conger: As I understand it, where you charge a man himself with what you say was used, say you charge him a pint, he may say it is only three-quarters of a pint, but charge it to him in ounces and you can get the exact weight, and not the amount of oil used on the different engines, it is the amount of oil that is issued to a man a month. That keeps the oil account straight. My suggestion is, that instead of measuring the oil to a man, the oil should be weighed to him, which would be more accurate.

Mr. Henderson: The system I spoke of contemplated having oil cans in common, not necessarily every man getting the same can each time, as the cans are all supposed to be the same size. As long as the oil can is full, it is of no moment whether he gets his own can or not; he merely was charged with the amount of oil as he came in that was used from the can.

Mr. John Mackenzie (N. Y. C. & St. L. R. R.): I understood the account was kept against the engineer and not against the engine. I do not understand how under the pooling system you are going to charge the engine with the oil; you must necessarily charge your engineer, not only with the oil, but with the coal he uses. Each man is charged with so much oil and so much coal a day, and at the end the record is kept by the man and not by the engine.

Mr. T. S. Reilly (*Railway & Engineering Review*): I would like to hear about the method of keeping the account of coal; it seems to me the books differ among ordinary men.

THE CHAIRMAN: I presume Mr. Wells is keeping tab on these questions.

MR. JOS. COCKFIELD (C. & N.-W. R. R.): I have read Mr. Wells' paper carefully, being interested, especially so inasmuch as on the road with which I am connected, we ventured recently on pooling engines or engineers. But from this paper, on the 12th page, you will note he says: "Men must have regular rest, while engines are needing only repairs." Can we not infer from this statement that the engines are lying in the roundhouse waiting for the regular engineers to get rest? I never could understand that this was necessary. We have always, when regular engineers were assigned to engines, had extra men take the engine and make a trip, the engines making just as much mileage, in fact, as though the engineers were in the pool. As I have said before, we have gone into this pooling system, and so far we are very well pleased with the results.

My friend, Mr. Deems, may wonder at this statement, as we have come to an issue on the pooling of engineers and engines, but we find, as has been said in the papers, that you have to prepare for any new thing that is introduced. The same thing in pooling engines or assigning runs, or any other method that presents itself where there is a change.

We went into this pooling of engines very thoroughly, by discussing the matter with the men and getting them interested, and when we started to do it we found it worked very successfully.

Now, our method in regard to handling that oil and coal question is about as follows: Each engineer has his individual engine and valve oil cans; small oilers are left on the engine. The coal account is taken individually with the engineer, the same as heretofore.

I also read in the paper in regard to making some comparisons with marine engines, hoisting engines, etc. I do not think there can be any comparison, because the locomotive has different conditions to contend with. In climbing a hill the engine is worked very hard, and in going down you shut off the steam, and I do not think there is any machine in existence that is abused so much or requires more care than the locomotive engine.

Now the matter of tools is a very important one in this connection, and we find, on entering into this, that it is necessary to have certain tools assigned to an engine and inspected by an inspector

provided for the purpose. We expect it is going to cost us a trifle more, going into this system, on account of the method we are required to adopt in taking care of the engine, first — setting up wedges, packing cocks and throttles in cabs, and such other duties performed by engineer. It is also necessary to employ some additional help to clean the headlights and parts of locomotive above the running board. This was heretofore done by the enginemen.

Mr. W. G. Wallace (C. & N.-W. R. R.): I would like to say a few words in regard to this pooling system. It seems that the pool is coming, and what we want is to get at it right. Now, as there are two sides to every question, there are two sides to this one, and of course the older man that has been accustomed to run a regular engine does not like the pool because he usually has the best there is any way, and he rather hates to give up a good thing; but the other man, that otherwise will always have to run the poorer engine, will like the pooling system all right. He says: "I would have a poor engine if I was running a regular engine, but now I get a crack at all of them." So it is, and as the young men are a little in the majority, I think they will see the pool put into effect. The matter of handling oil and coal is something that can be taken up by different systems of railroads in a manner that will give them the closest check on the engineers, and it does not matter whether you weigh the oil or measure it. In measuring, when you find an engineer who will put the valve oil measure on the stove so as to get all the oil out of it, no one is going to beat him very much. I think in the inspection of the locomotive is where you are going to make your success in pooling.

Suppose I am an engineer. I come in on an engine under the pooling system. Of course, I am tired when I get in, but I give the engine an ordinary looking over. The side rods may need a little keying, perhaps the main rods; the wedge may be a little slack, and several little things about the engine need attention; still she is not very much worse than when I got her. I am not going to trouble myself to get after those keys, and if she runs cool, and the brasses are not far enough apart so that the inspector will call my attention to it. Those keys have worked up a little with me; and when the next man takes her, it is the same thing. Soon it develops into a hot bearing, or the brasses are pounded out of shape. Now, if we go to work and inspect that engine, any good live inspector can set up a

wedge or key up the rod, and do necessary repairs on a locomotive, so that it ought to run. Now, when we call the engineer, and he goes out on that engine, he should not be held responsible for an engine failure under those conditions, unless it is through some neglect of his. If he neglects to fill the cups or properly lubricate the engine, why, then, he is held responsible for the failure ; but, with those exceptions, the engineer should not be held responsible for the engine failure, any more than the conductor should be held for a hot box on a sleeping car. I think, when you put your engines in as good condition as you can get them, call your engineer, and send him out with an engine which is in condition to make a good run or successful trip, that you will have the success in pooling that you expect to get, or that you are working for. If that is not done, then you can not hold the engineer responsible, and you get the results in failures. So far as the men with whom I come in contact are concerned—that is, the engineers—they like the pooling ; and if the cab fixtures are packed nicely, so that they can see out of the cab in cold weather, and such work as that done, I do not know why the men will not support that system.

Mr. Mackenzie : I believe this pooling system is brought out as a matter of economy. Is that the idea ?

Mr. Wallace : I presume so.

Mr. Mackenzie : We have, say, six passenger trains which we call very fast, on the line with which I am connected. They are not very fast, but it is fast for us. I think, if I were to undertake to pool the engineers on those passenger engines, and I were to say, " First in, first out ; take whatever engine there is on hand," I would get myself into trouble, for the simple reason that we know very well, when a man is acquainted with a run, he will handle it better than the man that is not; and in the pooling system, the men who would run these fast trains would only come on once a week. Now, they all have a better idea what that speed has got to be on that train, compared to one that has been running a week ; and I think, if we were to put an extra man on there once in a while, we would find he would not handle the train as nicely as the one that is regularly upon the train, and, as far as pooling is concerned, it will have considerable effect on that work.

Mr. Wallace : I understand this is a pooling of the engines, not a pooling of the runs. You may have your regular runs and assign your men to these runs, but you furnish the engine just the

same as you furnish the train and the conductor. What has been said regarding an engineer that is accustomed to handling a train is true. There are very few time cards that are made out, on which there is not some place, from one end of the division to the other, where there is an opportunity for a man to make up a little time, or to crowd his time a little when he is approaching a station where there is work to do, so that he can possibly leave that station on time, that a man not accustomed to the run would not do, which would result in a higher fuel consumption. With the engines in the pool, the man could have his regular run just the same ; simply the man is called for the run and takes an engine to the train, the same as a conductor ; you take care of the engine.

Mr. J. A. Graham (C. L. & W. R. R.): In regard to keeping tools on the engine, I think you all know that has been an open question for a long time. On page 13, the second paragraph, it says in the pool as we have it, each engine is equipped with headlight and signal oil cans, and the necessary tools in locked boxes, the keys being kept on a large board in the foreman's office. I have seen it tried several times to have keys returned at the end of each trip, but never knew it to be successfully carried out.

The matter of keeping tools on engines is quite an important question, and one I have always found, in my experience, very difficult of adoption, and unless the inspector is instructed to replace tools that are missing and then take the man to task for those that are gone, I do not know how you are going to take care of the tools. Pooling engines seems to be the coming practice, and if it is, we have got to be prepared for it ; but I think the majority of those that have had the direct handling of engines with that system will say that it is not entirely satisfactory. I do not think you can run engines as economically that way, on oil, at least, as you can where you have regular men on them ; nor do I think that an engineer that has to run one engine today and another tomorrow, and so on, is able to do quite as good work as he can where he has the one engine. When it can be so arranged, it seems to me that better results can be obtained where two crews run one engine, or having three crews run two engines, at least allowing the engineer the same fireman ; in that way the engineer and fireman learn to understand each other, and it seems to me better results can be obtained in that way.

Mr. H. T. Bentley (C. & N.-W. R. R.): Speaking of the han-

dling of tools on locomotives, the practice that we had in force was this: Each engineer was supplied with a small tin box with his number on; these boxes were large enough to contain all necessary small tools, water glasses, etc. When the engineer got off his engine the box was removed and placed in the store room so as to be ready when required for the following trip. With this method of handling them the engineers were directly responsible, as they could not complain of tools being lost by anyone but themselves. The large tools were kept fastened up in the back tank box and kept track of by the engine inspector, who reported when seals had been broken or tools were missing.

Mr. Henderson: A gentleman spoke of the question of taking care of tools; I think he referred to the way that matter was handled. On the Norfolk & Western road we had regular printed forms giving a full list of tools; when the engineer took an engine he was supposed to sign this receipt for the tools. It was his place to look in the box to see that they were there; when the engine came in on the other end, the inspector, or some one designated, was to see that the tools were in the box, and he gave a receipt to the engineer, so that if any tools were missing, and they found that the engineer had received them at one end, he was charged with the loss.

Mr. F. T. Benjamin (C. & N.-W. R. R.): In talking about pooling of engines, the question came up, How are the tools to be handled? There has always been more or less trouble with engineers over shortage of tools, when in charge of the engine. Before we entered into the pool, each engine was carefully inspected and shortage of tools made good by the roundhouse foreman, and a record made of same. After that the engineer was held responsible for all tools lost while the engine was in his charge. After adopting this rule, very little trouble was experienced owing to the loss of tools, as the men understand they have to make them good. Before entering into the pool it was talked over with the men, and they soon understood by going into the pool they would get more rest and the engines would also make an increased mileage. At one time I was very much opposed to pooling engines, but today I am very much in favor of it, and I believe all the large systems have got to come to it sooner or later. In talking it over with the men it will not be hard to adopt it, after they understand what is wanted.

One gentleman spoke in regard to keeping the cocks of the boiler

head in good condition. Every time one of the engines is washed out each cock is inspected, packed and put in good condition; the hole in the bottom water glass cock, also in gauge cocks are opened by the man who has the work in charge. The wedges are also cared for by one of the roundhouse men. At first, some of the older engineers did not want the wedges set up by anyone but themselves. It was found, when the wedges were set up on engines to which they had been assigned, that they were quite as slack as those on engines which had been run by younger men. When an engine arrives at the roundhouse it is inspected very carefully by the inspector, as well as by the engineer, and if anything is found which the engineer has not reported we take him aside and talk it over with him. On the second offense we are a little more severe.

One gentleman said, "Of course the old man is opposed to it," but we find some men that are opposed to anything new that is started; but in my opinion they will all be more in favor of the pool in the end than they are at present.

Mr. Rhodes: I want to say something, not so much on the question of pooling, as to speak in connection with the discussion of these papers before the Western Railway Club. I have belonged to this club for a number of years past, and I used to know the entire attendance; today, I find I do not know one-fourth of the members here; they look as though they were the new young men that are being drawn into our club discussions. I have no doubt that many do not know the author of the paper on piece work in railroad shops, or the author of the paper on pooling locomotives. Let us ask, who are these men? The superintendents of motive power from their roads? Are they master mechanics of any big system? No; the first man, I believe, is a practical machinist. The next man is running freight engines. Now let us see if a change is not taking place. The first paper would be creditable to any master mechanic; the second paper, I think, would be quite creditable to any superintendent of motive power.

When we were discussing the question of piece work prices, one gentleman agreed that if these things were equitably arranged and could be equitably arranged between the managers and the employes, that undoubtedly a piece work basis was the most equitable in paying for labor. How are we going to get this condition of things? It seems to me that we are going to get it by getting closer together.

I would say that this ought to be a red-letter day for the Western Railway Club, because we have been entertained and very much interested, in what? In papers from the rank and file, not from the head men. I say that this last paper on pooling locomotives would puzzle some master mechanics, some superintendents, some general managers to reproduce.

One of the last speakers said that, with regular engines, many minor repairs are often left undone, but that the pool got things accomplished, and that, where they did not have the pool, the men who made the repairs themselves would invariably put off and put off the repairs. This strikes me pretty hard, because I have just moved out into the west, and I have bought myself a piece of property, and I am a little particular about some things that I want to have done, but I am just tenacious enough to want to do them myself. The result is that there are a whole lot of things accumulating that do not get done, and I am gradually coming to the conclusion that I will have to get somebody to do these things for me if I ever expect to get them accomplished.

I think the first time my attention was called to pooling engines was on the middle division of the Pennsylvania railroad in the year 1877, under Mr. McCrea, who was then superintendent of that division. This was one of the beginnings of pooling, and it has been introduced and talked about in many meetings since then. We had a discussion at this Club in, I think, 1896, when it was up for a topical discussion. On the road I am connected with, we are very strongly in favor of pools.

We are also giving a good deal of attention to continuous running of locomotives. Although I am strongly in favor of continuous running of locomotives, I want to cite a case to show that the subject has not received the attention that it ought to receive. This spring we had four engines on a certain division, two through passenger trains west, and two through passenger trains east. Those four engines were worth $10,000 apiece—that is, $40,000. It was found that the run for the round trip was 339 miles, and it was found that the engines could be turned around and brought back to the starting point daily, and by doing so we would cut the money invested in locomotives in half. Instead of having $40,000 invested in engines, we had $20,000 invested in engines. Such economy is wonderful, where it is carried out to any great extent. Those two engines now

on that run make 339 miles a day, or 10,170 miles a month. What is going to make this method of handling these trains successful? It depends entirely upon the capacity of the engine to make 339 miles a day *without a failure;* and how are we going to make these runs day after day without failure? Simply by watching every failure, and by not resting satisfied until we feel that the cause of each failure has been investigated and bettered; and I would urge upon anybody who is trying to get more mileage out of engines, as far as the machinery is concerned, do not rest satisfied with a failure until you are able to answer satisfactorily this question, "What have I done to make this kind of accident less liable to occur?" When a man in the ranks is not able to answer such a question, he can always go to his superior and say to him: "Now, here we have had a broken valve; we have had trouble which occurred on the road. Now, for my information, tell me what you have done that is going to make this less liable to happen. Are you introducing something new, or what are you having done to make it less liable to occur?"

At another time, on a long run, there may be a hot eccentric, or a broken eccentric strap or bolts. Let us ask again, "What have we done to make hot eccentrics less liable to occur?" If we renew with the same kind of eccentrics, put in the same kind of bolts, I do not think we have done our duty, and long continued runs will not be successful. However small and insignificant engine failures may be, if we make them less liable to occur, I believe we will reach the condition in which our shops will be so careful, and our work will be so well done, that, in place of having some of the men advocate pooling, we will have master mechanics, and superintendents, and general superintendents, all recognizing pooling as the most economical way to operate locomotives.

The Chairman: If no one else desires to speak on the subject, we will ask Mr. Wells to close the discussion.

Mr. M. E. Wells: I do not know that I have very much more to say. I would like to answer Mr. Conger. He does not agree with me when I say that "it is the engine, and not so much the crew, that gets an important train through on time." I must say that what I have said is true in our experience. Our officials do not pick certain engineers for the important fast merchandise trains, but they do pay a great deal of attention to what engine goes on these runs. I will tell you where there might be a difference. If the train was late,

there might be some difference as to the amount of time the various engineers would make up.

In regard to the oil, we handle it in this way: We take our cans to the oil house, partly full or empty, as the case may be. The oil man has a measure with small pieces of wire soldered in crosswise, marking pints and half pints. He fills our cans, and can tell very closely as to how much it has taken and how much we are to be charged with. This is not as accurate as weighing, however.

In regard to coal records, tanks are filled to a uniform height at all division points by the hostlers. I take an engine with the tank filled, and, when I leave it, I am charged with the coal it takes to fill it again to this uniform height. While this is not absolutely correct, nor as near as might be got by weighing, it is very close and, I believe. would average very well, during a month, with even the weighing method.

In regard to comparing marine engines with locomotives, I understand very well that there is a vast difference in the work they do. All that I wish to argue and prove is that it is possible to get a great deal more work out of a locomotive under the pooling arrangement than under the old method of each engineer having a regular engine; and if two or three engineers can run one marine or stationary engine successfully, so two or three engineers can run one locomotive successfully. And our experience in the pool has proven that fifty-two engineers can successfully run thirty-seven different engines. The man in charge of the waterworks engines in the city of Omaha told me recently that their largest engine had run as long as a year at a time without having steam shut off. We cannot expect such performances from locomotives, but we certainly can expect more than five or six hours work out of each twenty-four.

As to inspection, I can, I think, safely say that it is the most important thing to be considered in the pooling of locomotives. Engine inspectors become very proficient in their work. I can safely say that they become expert—that is, when no mistake has been made in the selection of the man to start with. They must be trained men in their particular line. Do not imagine that all an inspector has to do is to be able to tell a loose nut when he sees it, and argue from that that almost anyone can inspect a locomotive, for "almost anyone" will not make the right kind of an inspector. I think the decrease in engine failures is quite remarkable with us, and I must

repeat here that it is certainly due to the right kind of inspection.

One gentleman has spoken of each engineer having his individual tools in a locked box which he transfers from one engine to another. We have very little trouble losing tools. A tool inspector looks over the engines when they come in, and any missing tools are checked up against the engineer bringing in the engine.

As a rule, an engineer has a regular fireman; but during very heavy business rushes it is found difficult to keep them together; and we have, during such a time this fall, had our engineers and firemen listed separately,—there being a greater number of the latter than of the former, so that, at such times, an engineer may run weeks without having the same fireman twice. But the trains make their time just the same, which certainly argues well for the high average ability of the firemen.

The prime object of pooling locomotives is to get greater mileage out of each engine. Now this can be done in different ways; and if there are a large number of trains, and the time card is so arranged, very good mileage can be made by doubling back and forth over divisions averaging about a hundred miles; but if the time card will not permit this, the mileage can usually be made by running through two or more divisions. Gentlemen, I thank you.

Adjourned.

The David L. Barnes Library

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

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THE regular monthly meeting of the Western Railway Club was called to order at 2 p. m., Tuesday, Dec. 19, 1899, in the Auditorium Hotel, Chicago. President H. G. Hetzler in the chair.

Following are the names of those who registered :

Akerlind, G. A.
Anderson, Geo. T.
Bigelow, Harry T.
Bischoff, G. A.
Brown, Geo. H.
Bryant, W. E.
Carroll, John T.
Carse, David B.
Cauvins, A.
Cheney, M. P.
Clark, F. H.
Conger, C. B.
Cooke, Allen
Crosman, Walter D.
Cushing, Geo. W.
Dunn, J. F.
Forsyth, A.
Furry, Frank
Gardner, J. W.
Haskell, B.
Hatswell, T. J.
Henry, W. L.
Hetzler, H. G.
Hill, Jas. W.
Hyndman, F. T.
Keeler, Sanford
Kirby, T. B.
Kuhlman, H. V.
James, Geo.
Jennings, D. F.
Johann, Jacob
Johnson, A. H.
Lane, F. W.
Luttrell, J. W.
MacKenzie, John
McMaster, T. J.
Mason, Thos.
Medway, John.
Mills, Geo. F.
Morris, A. D.
Murphy, Chris.
Noble, L. C.
Parish, Le Grand
Peck, Peter H.
Perry, A. R.
Platt, E. W.
Rapp, M. E.
Reilly, T. S.
Roberts, C. A.
Rupert, W. T.
Sanborn, John G.
Sargent, F. W.
Sargent, Geo. H.
Sawyer, E. C.
Scales, Richmond P.
Sceets, G. N.
Schevers, A. J.
Scott, G. W.
Shea, R. T.
Slater, F.
Smart, R. A.
Smith, R. D.
Stafford, B. E. D.
Stocks, W. H.
Street, Clement F.
Sullivan, Chas. L.
Synnestvedt, Paul.
Taylor, J. W.
Thurtell, B. W.
Tratman, E. E. Russell
Wickhorst, M. H.
Whitridge, J. C.
Williams, J. C.
Woods, J. L.

President Hetzler: The minutes of our last meeting have been sent to each of the members, and if there are no corrections they will stand approved as published. The Secretary will please read the names of the new members who have been accepted by the Board of Directors.

The Secretary then read the following:

W. B. Sharp, Patterson-Sargent Paint Co., Chicago, Ill.
G. H. Brown, Dist. M. M., C., U. & St. P. Ry., Dubuque, Iowa.
J. O. Bradeen, M. M., L. S. &. M. S. Ry., Norwalk, Ohio.
Thos. Knowles, Chief Engineer, Dearborn St. Passenger Station, Chicago, Ill.
F. R. Coates, Western Repr., Weber Joint Mfg. Co., Chicago, Ill.
A. W. Jones, Div. M. M., D. & R. G. R. R., Salida, Colo.
T. J. Sullivan, Gen'l. Foreman, Erie R. R., Huntington, Ind.
Chas. James, Foreman, Erie R. R., Huntington, Ind.
S. S. Voorhees, Chemist, N. Y. C. & H. R. R. R., West Albany, N. Y.
E. G. Edwards, Draftsman, N. Y. C. & H. R. R. R., West Albany, N. Y.
J. H. Van Buskirk, Chief Draftsman, N. Y. C. & H. R. R.R., West Albany, N.Y.

The President: We will now proceed to the paper of the day by Mr. Paul Synnestvedt. Mr. Synnestvedt will read his paper and make such comments and remarks as he desires.

Patents: What They are Not

By Paul Synnestvedt

It is not the purpose of this paper to present a lengthy treatise on patents, from a strictly legal standpoint, but rather to try and give to the members of the Western Railway Club a little instruction from the standpoint of a railway man, which the writer, from almost constant association with railway men and railway work, still feels himself to be, although for some years past his more immediate occupation has been the practice of patent law.

But few of our busy railroad men have had opportunity or occasion to apply their minds to studying the subject of patents, and it necessarily follows that but a very small proportion have any proper conception as to the nature of a patent right; or, to put it differently, what a patent is; or more accurately still, perhaps, what it is *not*, what relation one patent bears to another, and whence arise so many apparently anomalous situations as are encountered under our patent law.

Most men, who are blessed with at least ordinarily astute minds, naturally suppose that when an inventor takes out a patent he gets thereby a right to proceed unmolested with the manufacture, sale and use of his invention. That is not the case, however, as we shall see from a little investigation.

The origin of the erroneous idea above stated may, perhaps, be traced to the language employed in the patent grant itself, and in the constitutional clause which is really the basis of the patent system.

It was provided in the Constitution that Congress should have the power "to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." Under this provision of the Constitution, laws were passed providing for the grant of patents. The foundation upon which such laws are built involves the idea of a contract between the inventor and the public. In exchange for a full and complete disclosure of the invention, to be preserved in the public records, and accessible at all times to the public, the government agreed to undertake to secure to the inventor the *exclusive* right to his invention for a term of years. From the beginning, the language employed in the patent itself followed the wording of the above constitutional clause. Notice, for example, the fac-simile copy reproduced on page 173, signed by George Washington and countersigned by Thomas Jefferson, which is taken from what is said to be the first patent ever issued by the United States. It was granted Jan. 31, 1791, to Francis Bailey of Philadelphia, and related (to quote the patent itself) to certain "Methods, not before known or used, for forming punches, by which to impress on the Matrices of Printing Types, whether such Types be for Letters or Devices, as well as to impress on any Metal or other substance capable of receiving and retaining impressions, various Marks which are difficult to be counterfeited."

The grant recites that "the said Invention appears to be useful and important," and that "in pursuance of the Act entitled 'An Act to promote the progress of useful Arts,'" there is granted "to the said Francis Bailey, his Heirs, Administrators and Assigns, for the Term of fourteen years, the sole and exclusive Right and Liberty of using and vending to others the said Improvement, according to the true Intent and Meaning of the Act aforesaid."

The essential features of the grant have not really been changed since the foundation of the patent system over one hundred years ago.

On another page will be found reproduced a fac-simile copy of the grant of a patent recently issued to Mr. John W. Cloud, lately of Chicago, Ill., on a car truck. Examination of the terms of this modern grant will show that it does not differ materially in substance from the early one, except perhaps in the recital of the several steps taken by the inventor to procure the patent. It will be noticed that this grant also purports to convey "the exclusive right to make, use and vend said invention throughout the United States and the Territories thereof."

As a matter of fact, neither of the above grants give the inventor the right to make, sell, or use his own invention, but only the right *to prohibit or prevent others* from making, using or selling his invention for a definite number of years, for the infringement of which right he may, under the law, recover damages or profits from the infringer.

That by the grant of a patent the government does *not* give the inventor the right to make, sell or use his own invention, is evident from the fact that, prior to such grant, *he already has such right*, provided there are no patents to earlier inventors which he infringes; and in case such other patents or conflicting rights exist, the mere issue of a patent to him will not relieve from the charge of infringement any attempt to make, use or sell his patented device, whether such attempt be made by him or anyone else.

It is the word "exclusive" that really gives character to the grant—the right to *exclude* or *prohibit* others from doing something. Whether a patentee has a right to operate under his own patent or not, is entirely dependent upon the existence or non-existence of prior claims held by others, which would be infringed by such operation; and this is a question entirely different from the question as to whether this particular patentee's rights are valid, or infringed by later inventors.

What has been said concerning the nature of the patent grant will, perhaps, help to explain what so many have difficulty in understanding, i.e., how it can be possible for more than one to hold what appears to be a valid patent upon substantially the same thing. As a matter of fact, that is *not* possible; it is only an appearance. The difficulty generally arises in a case where one man holds what is known in patent law as a *broad* or *generic* patent upon a certain invention which has been improved upon by others in various ways, the others securing patents upon their several *improvements*. The man who holds a broad or generic patent has a right to prohibit its use by everyone else, so long as his grant continues alive; but he has *not* the right to prevent or prohibit others from exercising their inventive faculties in the development of *improvements* upon his invention, nor has he the right to prevent or interfere with others securing patents upon such improvements. That would not "promote" the progress of science and the use-

ful arts, but manifestly *retard* it. As has been well stated by the U. S. Supreme Court, the disclosure of a broad, generic or pioneer invention not only does not stop or check development along the same line, but rather serves to stimulate it.

To illustrate the distinction between what is known as a generic and what is known as a specific patent, and the rights of the parties holding the same, let us take, as an example, the case of a car coupler. Suppose A invents an improved vertical plane coupler or drawbar, comprising, essentially, three parts, a *head*, a *knuckle* and a *locking pin*. Suppose he is the first who has ever employed such three parts in combination in a coupler. He is entitled to and can procure a patent upon the combination between a head, a knuckle and a locking pin, his claim being entitled to the broadest interpretation by the courts.

Suppose B now takes a coupler made in accordance with A's invention, and, in using the same or studying upon it, works out a different form or arrangement of the locking pin and knuckle. B is entitled to procure, on the filing of proper papers, a patent on his invention, claiming his specific or particular improvement on A's generic invention. The existence of A's patent has not had, and obviously should not have, any effect at all in preventing B from securing a perfectly valid patent on the specific improvement which he has invented; for a patent, be it remembered, does not grant the right to *make* or *use* an invention, but only the right to prevent others from doing so. The government has given B a patent on his specific improvement, although it is to be remembered that there has been a prior generic patent issued to A, broadly covering all couplers employing a combination of a head, a knuckle and a locking pin. B's patent, therefore, does not give him the right to make or use his own invention, because his invention can not be made or used, except in making or using the invention which is already patented by A. Obviously, if this were not so, the value of A's broad patent would be destroyed as soon as anyone patented an improvement upon it.

The enforcement of such a rule would practically upset the whole patent system, since nearly every invention is or may be broad or generic to others, in the same line, which follow after.

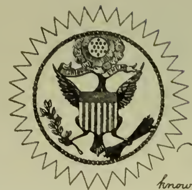
What the government does give to B is simply the right to *prohibit anyone else* from using that which he originated, or his particular contribution to the art, which in this case was a specific improvement upon the locking pin or knuckle of A's coupler. A, until his patent expires, can, if he chooses, entirely prevent B from putting his invention in practice, for the reason that B's invention is of such a nature that it cannot be used except in conjunction with the invention made by A. In the words of the patent practitioner, it is but one specific form of a generic structure, of which A holds the monopoly.

On the other hand, while A is entitled to prevent B, as well as everyone else, from making or selling any couplers embodying the broad or generic invention on which A holds a patent, B, by virtue of his patent and rights thereunder, can entirely prevent A from appropriating or making any use of his specific or improved form of knuckle or locking pin. If A wants to incorporate B's improvement in his coupler, he must get the consent of B by license or purchase. In the absence of such consent, he is confined to the use of his generic form of coupler, without B's improvements.

The above illustration may serve to make plainer the peculiar nature of a patent grant, already explained, i. e., that it is not a grant by the government of the right to make, use or sell a man's invention, but merely a grant of the right to prevent or prohibit others from making, using or selling it unless they pay tribute to the patentee. It is largely because of this distinction that it is possible for so many perplexing cases to arise in which it appears to the uninitiated as if a man, having procured a patent, has in some way been unjustly treated, because he finds, when he attempts to exploit his invention in practical work, some other patent previously granted stands in his way. It is incumbent upon patentees, as well as those contemplating purchases, manufacture, or other dealing involving patent rights, to find out just what relation the patent in controversy bears to others in the art, and guide their actions accordingly. The mere issue of a patent to an inventor, by the government, shows nothing more than the *prima facie* ownership, vested in the grantee, of a right to prevent others from making, using, or selling, the particular invention or specific improvement defined in the claims, and indicates nothing at all as to the existence or non-existence of any prior rights in others which may be infringed by commercial working under the patent. That can only be ascertained by personal investigation or search by an attorney. It is said the patent shows only *prima facie* ownership, because all patents are subject to be defeated in case proper defense can be brought against them in the courts.

Mr. Synnestvedt: With the permission of the Chairman I will add a word or two to the substance of this paper, which, as originally drawn by me, was over twice as long as it is now, a large quantity of matter which was not strictly relevant to the particular point that I wanted to make plain having been stricken out in revising it.

There has been, among many railroad men with whom I have come in contact, a disposition, which is very apparent, at times, to take an unfriendly attitude toward patents, and, in fact, toward the entire patent system of the United States. This is not without a cause, and, in a measure, a just cause. It arises, however, from a misunderstanding of the nature of the patent grant—not so much a failure to understand what a patent is, but, as I have tried to put it in this paper, a failure to understand what a patent is not. The idea has been that in granting a patent to an inventor the government deprives the public of something which had theretofore belonged to it, which you can see is not consistent with the fundamental principle of the patent law, understanding such principle to be to grant to an inventor simply the right to prohibit others for a limited period of time from making use of something which was the product of his own brains. It did not exist before, and therefore could not have belonged



The United States.—

To all to whom these Presents shall come—Greeting—

Whereas Francis Bailey of the City of Philadelphia in the State of Pennsylvania, Printer, hath invented certain Methods not before known or used, for forming Punches, by which to impress on the . . . . Matrices of printing Types, whether such Types be for Letters or Devices, as well as to impress on any Metal or other Substance capable of receiving and retaining Impressions various Marks which are difficult to be counterfeited, and the said Invention appears to be useful and important: These are therefore in pursuance of the Act, entituled "An Act to promote the progress of Useful Arts", to grant to the said Francis Bailey, his Heirs, Administrators and Assigns, for the Term of fourteen Years, the sole and exclusive Right and Liberty of using, and vending to others the said Improvement, according to the true Intent and Meaning of the Act aforesaid.—

In Testimony whereof I have caused these Letters to be made patent and the Seal of the United States to be hereunto affixed. Given under my Hand at the City of Philadelphia this Twenty ninth Day of January in the Year of our Lord one thousand seven hundred and Ninety one and of the Independence of the United States of America the Fifteenth.

G. Washington

By the President

Th: Jefferson

City of Philadelphia January 29th 1791.—

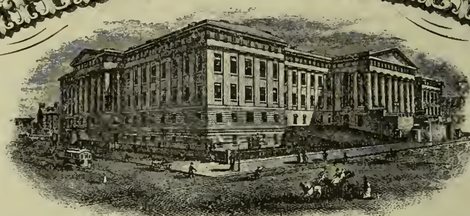
I do hereby certify that the foregoing Letters patent were delivered to me in pursuance of the Act, entituled "An Act to promote the progress of useful Arts"; that I have examined the same, and find them conformable to the said Act ——— Edm Randolph
Attorney general
of the
United States

Type Patent—

Delivered to the within named Francis Bailey this thirty first of January 1791 —

Th: Jefferson

The United States of America.



No. 625,925.

To all to whom these presents shall come:

Whereas John W. Cloud, of Chicago, Illinois,

has presented to the Commissioner of Patents a petition praying for the grant of Letters Patent for an alleged new and useful improvement in

Car-Trucks.

a description of which invention is contained in the Specification of which a copy is hereunto annexed and made a part hereof, and has complied with the various requirements of Law in such cases made and provided, and

Whereas upon due examination made the said Claimant is adjudged to be justly entitled to a Patent under the Law.

Now therefore these **Letters Patent** are to grant unto the said John W. Cloud, his heirs or assigns for the term of Seventeen years from the thirtieth day of May, one thousand eight hundred and ninety nine the exclusive right to make, use and vend the said invention throughout the United States and the Territories thereof.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington ... th day of May ... of our Lord one thousand eight hundred and ninety nine, and of ... endence of the United States of America the ... hundred and twenty third.

Webster Davis
Assistant Secretary of the Interior

Countersigned C. H. Duell
Commissioner of Patents

to the public. If it was not the product of the inventor's brain, his patent is subject to be defeated in the courts. In such case he will, in the first instance, have a hard time to get a patent, and after he gets it, it is practically worthless because of its invalidity. If the improvement or invention made by a man is of no commercial or practical value, there is no hardship worked upon the public by granting to that man the exclusive right to use that thing for a period of years, because, certainly, if it has no value nobody wants to use it.

In this way the government, by the patent system, grants to an inventor, to a man, who, by meritorious service has originated or developed something new, a right from which he gets a reward proportioned directly according to the value of the thing which he has given to the public. That is the theory and, to a large extent, the practice carries that out.

There is no doubt that very many great abuses have arisen under our patent system, and it is sincerely to be hoped that legislation will wipe them out.

Some steps in this direction have been taken recently by the enactment of statutes curtailing certain privileges which have been very much abused—privileges relating to the amending of pending applications, for instance. Now when a man makes an invention and desires to apply for a patent, the law requires the filing of an application in the United States patent office. The patent office has a large corps of examiners divided into some thirty-six different divisions, each division having charge of a particular class, or related classes, of inventions, as the railway division, for example. Every application is filed in the particular division to which it relates, each case being given to some individual examiner, or assistant examiner, who takes it up in its turn and searches through the records to see whether it is new or not, who examines the papers to find out whether everything has been presented in proper form or not, and who then communicates with the inventor, advising him whether the case is allowable, or whether it is objectionable, and, if so, stating the reasons for the objection. The applicant then has to trim down the scope of his claims to suit the state of the art; in other words, he must contract the boundary line which he asserts embraces that which belongs to him individually, so as not to include within that line anything that belongs to anybody else.

The old statute gave to the applicant, for every action he had upon

a case presenting new references or reasons for rejection, the right to two years' time in which to file an amendment, and by abuses which arose under that statute cases were not infrequently kept pending in the patent office for many years (some of them as long as twenty years), and people coming along in the meantime with intervening rights would start out with the manufacture of devices which they thought were new with themselves, and later find out that somebody who had an application pending in the office long prior to that time would get a patent and stop them from continuing their manufacture. The time limit for such amendments has now been cut down to one year, just cutting the time of the old privilege in two, which is a long step in advance, and the office force being now nearly up to date with its work, and being more rigid in requiring prompt amendment, abuses such as have just been described are reduced to a minimum.

Another improvement has been made recently in the amendment to the statutes, by which, in suing for infringement, recovery cannot be had over six years back. You say that six years seems a long while. It is much shorter than the period allowed prior to the enactment of this amending statute, which covered seventeen years, the whole life of the patent.

I mention the above as incidents to show that there is a disposition on the part of Congress to remedy the abuses that have arisen under the patent system, and counsel that when you are disposed to take an unfriendly attitude toward it because you can see that there has here and there grown up some abuse which appears to you to work injustice, you should pause and think, not of the abuse, but of the use, and not take an attitude which will do damage to a thing which is of value to every industry in the country—to the railroads as much as any other—but treat it with consideration.

President Hetzler: Gentlemen, you have heard the paper; discussion is in order.

Mr. C. L. Sullivan (Cloud Steel Truck Co.): I read the paper at my office very hastily, and though I am somewhat familiar with patent office practice as a mechanical engineer, I ran across something which seemed to me somewhat of a contradiction or difficulty in the paper.

In the first place, the author of the paper says that the intent of a patent is not to give the patentee the right to manufacture and sell, and so on, his invention, but primarily to exclude others from making and

selling his invention. If that is so, I would like to ask the author of the paper the strict meaning of the two words "to make." On page 2, in recounting what some of the wording of Mr. Cloud's patent is, it says : "The exclusive right to make, use and vend said invention," and so on. I say, I would like the author to give the definition as applied to patent office practice of the words "to make." In other words, I would like to know if that does not entitle the patentee to manufacture his invention ?

Mr. Synnestvedt : I will say in reply to that, that if the patentee before he got his patent had a right to make it, he did not get any additional right by the issuing of his patent. If he did not have a right to make it when he got his patent, by reason of the existence of some prior patent having a broad claim, the terms of which he infringed, the issue of the patent to him gave him no right to make it.

That is, the right is threefold ; it is the right to prohibit others from *making*, *using* and *selling*, and each one of these can be treated, and must be treated, separately.

Now, if an inventor gets a patent and there is some prior patent in existence which has some broad claim which he infringes, he does not, when he gets his patent, get the right even to make the thing. The making or manufacturing of a thing is just as much an infringement as the selling or using of it. The manufacturer who makes it, the agent who sells, and the party or buyer who uses it, are all equally guilty, and are all liable to be stopped by an injunction issued out of court.

Now, if I have not made myself clear, I would be glad to have further questions asked.

Mr. Sullivan : If the inventor previously had a right to make a device before he procures a patent, which patent in the wording gives him the exclusive right thereafter to make—that is the point we want to make clear—why he can not continue making, exclusively, the article. It seems to me that the patent right not only continues the right which he previously had, but would he not have the right to make an article which at first sight might not appear to him to be patentable, after making it for a period, long or short, should he apply for and procures the patent ? When the wording of the patent gives him the exclusive right to make that device, it seems to me he continues to have the exclusive right to make the device. I would consider that so if I were to apply for a patent.

Mr. Synnestvedt : It seems to me the difficulty arises from two things. To begin with, the patent relates only, or, as the term is, covers only the invention which was novel and original with the patentee. Whatever was novel or original with the patentee was not the property of the public before that time, nor known to the public. It was known to the patentee, perhaps, before he applied for his patent, and, as stated in this paper, he had a perfect right before he got his patent to manufacture, provided there were no prior rights in the hands of others which he infringed by so doing. The difficulty is one, then, as to the existence of prior rights in others, and the patent does not change his status as to that. The patent is solely a right to prohibit somebody else from taking advantage of that new thing which he introduced for the first time.

The grant of such a right is entirely consistent with the existence of a prior right on the part of somebody else to prevent him from making the thing which his patent covers, in a case where, as I have tried to explain, the relation between inventions is that of a generic and specific patent. I certainly do not desire to be understood as saying that when a man gets a patent, any rights that he had prior to that time are taken away from him, because, obviously, if at the time he got his patent he was engaged in the manufacture of the thing covered by his patent, and thereby did not infringe anybody else's right, his status as to that is not changed by the granting of the patent. He has just as much right to continue as he had before, and no more. The only additional right he has obtained is the right to stop somebody else who tries to appropriate the thing which he has originated, his specific and particular improvement, the product of his own brain, which he, for the first time, introduces to the public, and in exchange for the disclosure of which he gets this grant.

Mr. J. W. Luttrell (Illinois Central R. R.) : Say that I invent a machine, and find that it does not infringe other machines used for the same purpose, but I do not care to have it patented, have I the right to make, use and sell this machine?

Mr. Synnestvedt : Yes.

Mr. Luttrell : Then if I want to prevent others from making that machine I must have it covered with a patent. Then I do not get this patent with the object of empowering me to manufacture the machine, but merely to enable me to prevent others from manufacturing it. Is that correct?

Mr. Synnestvedt: Precisely; yes.

President Hetzler: We have a written discussion from Mr. J. Snowden Bell, of Pittsburg, Pa., which I will ask the Secretary to read.

The Secretary read the following:

Pittsburg, Pa., December 18, 1899.

Joseph W. Taylor, Esq., Secretary Western Railway Club,
667 Rookery Bldg., Chicago, Ill:

Dear Sir:—I expected to be present at the meeting of the Western Railway Club tomorrow and to take part in the discussion of Mr. Paul Synnestvedt's paper on Patents, but being prevented by an unexpected change in my engagements, I submit the following brief statement of my views:

Upon a somewhat hasty examination of this paper I am led to the same general conclusion as I recently expressed regarding the new Atlantic type engines of the C., B. & Q. R. R., viz.: that while I will not say they are not as good as they ought to be, they are so good that they ought to be better. By "better," in the case of the engines, I meant that they should have had wide fireboxes, and in the case of the paper, that it might, with advantage, and without being too lengthy, have given the members of the Club some suggestions as to the course which it would be well for them to follow in the earlier stages of invention, in order to stand in as strong and safe a position as possible in the Patent Office, in the event of a contest with another applicant who is, either rightfully or wrongfully, making a claim to the same invention. The inventor is, in most instances, an unwilling party to such a contest, which is known as an "interference," and is instituted for the purpose of determining which of two or more applicants is the prior inventor and entitled to a patent, and which is usually lengthy and expensive. It will therefore be readily seen that any preliminary precaution or measure of preparation which would tend to clearly establish the right of an inventor, in case he should be brought into an interference, is of importance and value to him.

Suppose that A, of Chicago, and B, of San Francisco, independently make applications for a patent for an improvement of any description, both claiming the same invention. If it be found by the Patent Office that the invention is novel and patentable, the question arises whether A or B is entitled to a patent, and, unless concession of priority is made by one party to the other, it must be settled by an interference, in which testimony may be taken on both sides, and which is determinable by the decisions of one or more tribunals of the Patent Office, or by the Court of Appeals of the District of Columbia, if carried to that court.

It is well settled, as a general principle of law, that he who first conceives an invention is entitled to priority, if he has proceeded, *with reasonable diligence*, to reduce the invention to practice. There are two forms of "reduction to practice" known to the law; one is termed "actual" reduction, and consists in constructing and operating a device or machine containing the invention, and the other, which is termed "constructive" reduction, consists in filing an application for a patent for the invention. "Actual" reduction to practice, as above defined, is stronger and more conclusive than "constructive" and should always be made as

early as possible by the inventor, if in his power to do so. As soon as it is clear to him, as will be usually demonstrated by an "actual" reduction to practice, that the invention is complete and in practical form, he should make his "constructive" reduction or application for patent.

It is to be observed that the question of *diligence* is, in the most of cases, the vital one in an interference, and that therefore it does not follow that the inventor who was earliest, either in the date of his conception of the invention or of his reduction to practice, is necessarily the prior inventor in the eye of the law. If he is shown not to have been *reasonably* diligent, the party later in conception or reduction will be held to be entitled to the award of priority and to a patent for the invention.

Having the above general rules in mind, an inventor should in every case be particularly careful; *first*, to record and fix the date of every step which he takes in connection with his invention, from its conception to its reduction to practice; *second*, to make what has been above explained as an "actual" reduction to practice, just as soon as he possibly can; *third*, to satisfy himself that he has brought the invention to *complete* and *practical* form (by which is meant complete in all particulars except mere commercial sizes and proportions, which are supposed to be determined by those who are familiar with the art); *fourth*, to file an application as early as practicable after he has so satisfied himself. If his circumstances are such that he is unable to make an early "actual" reduction, he should work out the invention as fully as possible in the form of drawings and description, and make an application for patent ("constructive" reduction) as soon as possible. Every sketch, drawing, photograph or description relating to the invention should be dated and, if possible, witnessed by one or more persons who could, if necessary, verify the date, and it is a good plan for the inventor, as soon as the conception of the invention is complete in his mind, to make a sketch or drawing illustrating it sufficiently to make its general and ruling features plain, append a short description to the sketch, and have it dated and witnessed by two intelligent and reliable persons, upon whom he could call to testify as to its date, if it should become necessary, in the course of time, to do so.

In many instances within my observation, great delay and expense have been occasioned, and in some, the inventor's rights have been sacrificed, by the difficulty or impossibility of clearly proving dates of conception, drawings and sketches, disclosures of the invention to others, and other matters preliminary to reduction to practice, this being generally resultant upon a failure to record dates of these things at the time, and the inability of the inventor or his witnesses to accurately remember facts and dates, with no records to refer to, after the lapse of considerable time. The simple precautions above suggested will always be valuable, and sometimes essential, and they may be the means of saving the inventor from a protracted and expensive interference. Last, but not least, never file a "caveat." It is a delusion and a snare, conferring no protection whatever, involving a useless expenditure of time and money, and being positively prejudicial in leading the inventor to an unfounded sense of security, and putting him on record as not having completed his invention at the date of filing of the caveat, when, as a matter of fact, the reverse may be the case.

J. SNOWDEN BELL.

The President: There are other phases of the question which might be argued. Mr. Street, we would be pleased to hear from you on this subject.

Mr. C. F. Street (Dayton Malleable Iron Co.): I do not believe I have anything of importance to say on this subject. There is one matter in connection with this question of patents which has impressed itself on my mind, and that is the seeming recklessness of the patent office department in issuing patents.

I remember distinctly, about two years ago, of securing from the Patent Office a copy of a patent which had been issued on what was, to all intents and purposes, the regular M. C. B. draft rigging. The drawing on which the patent was granted was one which was exceedingly crude, and represented the most common and ordinary application of the M. C. B. standard rigging, as it has been in use some thirty years; in fact, one of the oldest types known. Of course, it must be difficult for the examiners of the Patent Office to catch up anything of that kind, but it would seem to me a thing which is so well known as this application should be familiar to an examiner.

Another thing which struck me in granting patents is the seeming similarity between different patents. On two or three occasions I have checked up claims in patents which, so far as I could see, were almost exact duplicates, and which had been issued only two or three months apart. Of course, to the uninitiated these things seem very strange, but there may be some good and legitimate excuse for such things happening in the Patent Office.

There is one feature in connection with the patents which has been called to my attention two or three times, and that is the issuance of a patent on a specific construction. I met with a railroad man a short time ago who had obtained what he supposed were very broad claims. The patent had been granted and he supposed he had very important claims, but when they were carefully analyzed it was found that a slight change from the construction shown in his application would make it possible to use his invention without infringing.

Mr. Synnestvedt: Mr. Chairman, in reply to the gentleman's remarks, I would like to say one or two things in addition to what I have already said.

To begin with, it is just as hard, and I think I can say truthfully, harder, to get a good patent today than it was years ago. The Patent

Office has issued a great many poor patents, partly through the fault of the office, but more largely, I think, through the fault of the applicants.

The fault of the office is largely excusable because of the constant increase in the mass of material that has to be examined by the office, and up to within a very recent date that material, comprising upwards of 1,000,000 issued patents (including the United States and foreign patents), was not properly classified; the classification was something fearful to behold, and to make a reliable search was almost a hopeless task. By persistent effort, however, a classification division has been established in the Patent Office, with quite a liberal appropriation to take care of its expense, and that division is now employed in revising the classification and appears to be doing the work very thoroughly and well. There is no doubt at all but that, when the work is finished and the new classification becomes familiar to the various officers in the Patent Office, there will be a marked improvement in the work done by the examining corps.

You can readily understand the difficulty of making such an examination as an application properly requires in a class such as, for example, rotary engines. There are, if I am not mistaken, over four thousand issued patents on rotary engines on file in the office, and there are a great many other classes in which cross references may be found which also have to be examined.

The like may be stated with reference to pneumatic tools. Search in this art should be carried into classes which people in the ordinary study of the subject would never think to investigate at all, but according to the new system of classification all these several related classes are to contain cross references to guide the examiners in making their search. For instance, under a certain special class will be an entry, "See also rock drills, dental pluggers," etc., and to make a thorough search the examiner goes into those additional classes and examines the patents under them.

The above will serve to explain, as I stated, some of the mistakes made by the Patent Office. The mistakes made by applicants must be explained on a little different ground. First, because of the lack of proper appreciation as to what the grant confers, which, I think, lies at the foundation of a great deal of this trouble and misunderstanding.

A man files an application with the idea that a patent will give him

a right to make his invention. It follows, of course, that when he has his patent he has his right. If he continues business for a little while, he stumbles into two troubles—first, notice from somebody else that he is infringing their rights, and, second, the discovery by him that somebody else is making his identical structure.

As to the notice of infringement, he finds on investigation by a patent attorney that, as a matter of fact he *does* infringe, and that the grant of the patent to him did not give him the right to make, use or sell his own invention, but only as I have stated to you, the right to prohibit others from so doing; that before his patent was issued other patents had been issued, or another patent, to some one prior to him which contained broad, sweeping claims, the terms of which cover his device; he must either pay tribute to the prior patentee, or abandon further attempt to work his invention.

As to the manufacture of the device by others, which he thought he was protected against, he finds when he serves notice upon them to stop, that his patent does not fully cover that which belongs to him. His claims are drawn too narrowly, as the speaker has remarked, and cover only the little details of construction, and the slightest change one way or the other will serve to evade them.

The only moral that I can draw from all this is to counsel you in patent matters always to look out for two things—first, make a search to find out whether you have a right to make and sell your invention before you go ahead with the manufacture (which is a different matter entirely from procuring a patent); and, second, when you file an application for a patent for the purpose of stopping other people from making or selling your invention, get such a claim in that patent as will properly protect you.

That can *not* be done by filing three or four claims written offhand, and when one or two of them are passed, striking the rest out, and allowing the patent to issue with those claims only which went through without objection. The proper way is to study the invention, to find out what are the essential features of novelty and utility; to draw claims on those worded as broadly as it is possible to word them, having due regard for the requirements of the law, so that others can not appropriate the invention by making slight alterations in the structure, and then put forth a strenuous effort to get such claims allowed. All of this is a work which requires the utmost care, and is, I think, the most important work connected with the patent busi-

ness, and yet, strange to say, the work which is most generally neglected.

Mr. Sullivan: Several years ago, when I was working at the drawing board, I had some patent office work to do for an inventor, and during the course of the work the attorney who had the patent matter in charge, in the course of certain remarks made this statement for the edification of the inventor, that if the device (a device gotten up to plane a piece of wood or lumber), if it could be used for digging potatoes, the patent would cover it as a potato digger. In other words, what he meant to say was, that the inventor was entitled to the invention in all possible ways in which it could be used.

Now, to make that clear, I sent to the Patent Office for a file of patents for a certain device, and there were a couple of hundred patents forwarded to us. In looking them over I found some patents on—well, one was a bucket, a metal bucket; there were two or three odd things of that sort that on the first glance bore no more resemblance to the device I had in hand than anything in the world, yet a closer inspection showed that the same device was also common to the invention I had in hand. I mention this to bring out the point that it is necessary on the part of the inventor to make his specifications, and his claims also, as broad as possible, so that when he comes to operate he may not be headed off by some other patent on a device which it is presumed is dissimilar, and yet in an essential construction is similar to the intended invention.

The President: If there is no further discussion on this subject we will take up the topical discussion on the closing of the slot in the M. C. B. knuckle. Mr. J. W. Luttrell will open the discussion.

Mr. J. W. Luttrell (Illinois Central R. R.): By way of opening the discussion this afternoon on the subject of closing the pin hole and link slot in the M. C. B. Knuckle, I will quote a few facts as I have found them in my experience.

It is recognized by all railroad men that the knuckle is the weakest part of the automatic coupler. This being the case it is our duty as representatives of railroads to locate the trouble, and from investigations I have made, I find that a very large majority of failures are due to the pin hole and link slot in the knuckle.

In order to satisfy myself on this point I had 200 knuckles taken at random from the scrap pile, regardless of cause of failure, and on inspecting them I found that 60 per cent. had failed through

the pin hole, and 11 per cent. through the link slot; 71 per cent. of all the failures was due to weakness from pin hole and link slot.

On June 30, 1899, the Illinois Central railroad had thirty-one thousand nine hundred and ninety-seven (31,997) freight cars equipped with M. C. B. couplers, which brought into use sixty-three thousand nine hundred and ninety-four (63,994) knuckles, and during twelve months ending June 30, 1899, five thousand seven hundred and sixty-eight (5,768) knuckles were broken, or nine per cent. (9%) of the total in use. As I have just stated, seventy-one per cent. (71%) of the failures I inspected was due to weakness caused by the pin hole and link slot, leaving twenty-nine per cent. (29%) due to other causes. We therefore find that during the twelve months period, four thousand and ninety-six (4,096) knuckles failed on account of pin hole and link slot, and one thousand six hundred and seventy-two (1,672) from other causes.

These figures show that in the operation of thirty-one thousand nine hundred and ninety-seven (31,997) cars during twelve months, four thousand and ninety-six (4,096), or six and four-tenths per cent. ($6\frac{4}{10}\%$), of the knuckles in use gave way from the cause in question.

I find from statistics that we have in use on railroads in the United States approximately one million three hundred thousand (1,300,000) freight cars. Assuming for sake of argument that the experience of other roads has been similar to ours, namely, that six and four-tenths per cent. ($6\frac{4}{10}\%$) of the two million six hundred thousand (2,600,000) knuckles in use fail annually from weakness of the pin hole and link slot, or one hundred and sixty-six thousand four hundred (166,400) knuckles, which at average current market price of one dollar and sixty-five cents ($1.65) each, shows a loss to railroads of about two hundred and seventy-four thousand five hundred and sixty dollars ($274,560.00) per year.

Recognizing the fact that the Safety Appliance Law prohibiting the operation of any car not equipped with automatic couplers will be made effective at an early date, I would recommend that as soon as this law goes into effect, that the weakness causing the large loss just mentioned be overcome, by closing the pin hole and link slot, and in doing this I desire to call your attention to another great benefit to be derived from this change namely — the increased wearing surface of the inner face of the knuckle which will very materially prolong its life. With the knuckle, as at present, the wearing

surface is about seventeen and one-half (17½) square inches; with the link slot closed it would be increased twenty-eight per cent. (28%), or to twenty-two and one-half (22½) square inches.

It is a well known fact that when the inner face of the knuckle is worn beyond a certain limit, cars become uncoupled, when in motion, without disarrangement of the locking device. The closing of the link slot will improve this condition twenty-eight per cent. (28%), it having increased wearing service to that extent.

The proposed change in the knuckle will increase its weight about nine and one-half (9½) pounds; also increase its cost thirty-eight (38) cents, which, however, is insignificant when compared with the saving to be effected by its closing, for, as I have shown above, nine per cent. (9%) of all knuckles in use fail annually, and six and four tenths per cent. ($6\frac{4}{10}$%) of them fail through the pin hole and link slot, leaving two and six-tenths per cent. ($2\frac{6}{10}$%), or sixty-seven thousand six hundred (67,600) knuckles failing from other causes throughout the United States, and it is on this number we would have to pay increased price of thirty-eight (38) cents each on account of increased weight, or twenty-five thousand six hundred and eighty-eight dollars ($25,688.00), leaving a net saving of two hundred and forty-eight thousand eight hundred and seventy-two dollars ($248,872.00) per annum to railroad companies by closing of the pin hole and link slot in M. C. B. knuckles, to say nothing of the benefit derived from the increased wearing surface.

President Hetzler: Gentlemen, this is a very interesting subject, and there should be considerable discussion. Mr. Smith, we will be pleased to hear from you.

Mr. Smith: I have nothing to say just now.

Mr. Sullivan: I have had some experience in the matter which Mr. Luttrell writes so well on, that is, the closing of the slot in the knuckle. A few years ago I was connected with one of the malleable iron companies which is handling automatic couplers, and on one of the roads with which it had some considerable business and on which road the majority of the cars were equipped with automatic couplers, the suggestion was made by some one that they try the experiment of closing the slot in the knuckle on the front and back of the engines and the results were so satisfactory that the road almost immediately, or as fast as the work could be done, changed the knuckles on the cars of its own line, that is, on the cars that were kept on its own line.

It was an ore hauling road, and so kept a large number of cars on its own line. I cannot recall the figures, but the saving was very material, not only in the matter of knuckle breakage, but also in the wear of knuckles. That was one case demonstrating the value of closing the slot and pin hole in the knuckle.

Of course, after a majority of the cars of the country are equipped with the automatic coupler, there will be no need of the slot and the pin hole, and then it might as well be closed as not. There will be some trouble met with in doing that, because of the increased difficulty of making the knuckle sound; the coring will have to be carefully done.

In the case of the knuckles I have in mind, in closing up the slot they simply closed it in the pattern, and did not take into consideration carefully enough that there would be trouble from increased shrinkage, etc., and they did meet trouble at that time, but it was easily overcome after it was once met and understood.

I think, from my knowlege of automatic couplers, that all the advantages will be gained that Mr. Luttrell speaks of, in closing the slot and the pin holes.

President Hetzler: Mr. Sullivan, you undoubtedly had considerable trouble in making couplings on sharp curves. Usually people have considerable trouble in that, where two cars are standing on a sharp curve.

Mr. Sullivan: Without the use of the link?

The President: Yes; without the use of the link between the two couplers.

Mr. Sullivan: In making coupler tests I have found curves on which you cannot make automatic couplings. I tested seven or eight couplers at one time, on a piece of road in that particular, trying couplers on curves, and found they would not couple on a curve; that is, curves in the shop yards. Of course, such a curve is not often met with.

Mr. Luttrell: I would like to ask the degree of curve where you had this trouble?

Mr. Sullivan: That was some three years ago. I do not recall what the degree of curve was; it was a pretty sharp curve, where the track came into the yard and then went around a little building in the yard, and it made a very abrupt curve to get around the building.

Mr. J. W. Luttrell: We have in our Burnside shop yard 20-de-

gree curves, and experience no trouble in coupling cars on them. Six-degree curves are about as short as are used in main line tracks. Sharp curves in shop yards should not stand in the way of an improvement in the construction of the M. C. B. coupler.

Mr. Sullivan: I do not think it is an objection. I do not think there will be any difficulty in providing schemes for coupling cars on such curves as that, even.

Mr. P. H. Peck (C. & W. I. R. R.): My experience agrees with Mr. Luttrell's precisely. We find a great many couplers where the lug will break off. A great many times the pin holes get so flat that you can not get an ordinary sized pin in, which shows it would not do that provided it was solid, and I agree with Mr. Luttrell that most all of the breakages come from that slot or the pin hole, or the two combined. We find that experience borne out by our scrap pile, the same as Mr. Luttrell has.

Mr. Street: I have a suggestion, though I do not want to be considered as advocating it. It occurs to me at the present time that it might be well to close up the slot, but to leave the pin hole. I have not given the matter enough study or thought to know whether it would be a good thing or not, but there is no reason, so far as I can see, why the knuckle would not have ample strength if the slot be filled up and the pin hole left, and it would be a simple matter to use an inverted U bolt through the pin holes to pull the cars off sidings and around sharp curves. The bolt can be made to drop into each knuckle and have sufficient length to prevent a variation in the height of the cars from pulling it out of the one knuckle. It seems to me the greatest weakness in the knuckle is caused by the slot and not by the pin hole. I doubt very much if the knuckle would flatten with the pin hole if it was not for the slot.

I do not wish to be understood as advocating this plan, as it is merely a suggestion that occurs to me while sitting here.

Mr. Peck: I asked that question about a year ago. I heard of the device and thought it was a good one, but possibly never mentioned it. They took two knuckles and put a link between them, and used a strip over the top of the knuckles resting on the drawbar, so that it would not drop through the drawbar. That looked like a very simple device.

Mr. J. W. Luttrell: In my examination I was very careful in locating the weak points of the knuckle. Of the 200 damaged knuckles

examined, 120 had failed through the pin hole and 22 through the link slot. The closing of link slot with pin hole remaining will, to some extent, strengthen the knuckle, but my experience is such as to convince me that the pin hole is a greater detriment than the link slot. I am of the opinion that both should be closed, and I believe that if the members of this Club will make a careful investigation they will endorse the stand I have taken.

Mr. R. D. Smith (C., B. & Q. R. R.): I think that we all agree with Mr. Luttrell that it is advisable to abolish the slot and the link pin hole in the knuckle of the M. C. B. coupler, but, as I understand the question, the most important part of the problem is to make a provision for pulling cars out of places where the M. C. B. coupler will not operate. There are many industrial concerns in Chicago that have tracks on which the couplings cannot be made with M. C. B. couplers, and I believe that all the roads entering Chicago also have a few such places on their tracks. To my mind the devising of some means of pulling these cars from just such places, when the link slot and pin hole are discontinued, seems to be the vital factor of the discussion, and I have hoped to hear suggestions made with this end in view.

I, and probably most of the other members, have noticed a ring on the corners of Pennsylvania cars, and also on the B. & O. cars, which apparently is there for the purpose of pulling cars out of places where couplings cannot be made. I have noticed these rings for several years, and it has been suggested to me that a device of this kind would be a good thing to use when the link slot and pin hole of the M. C. B. knuckle is closed up. I do not, however, believe that anything of that sort would be accepted, as it would require a chain or a switch rope, and make too much slack between the cars even in pulling them a short distance around short curves.

We have used a loop, like that suggested by Mr. Street, in our passenger yard, but it requires the presence of the pin hole, and I think it is equally as important to close up the pin hole as it is to close up the link slot opening. There have been suggestions made to me regarding yokes to slip over the two knuckles, and my friend Mr. Forsyth, sitting alongside of me, has made a sketch of what might possibly be a good arrangement. It is simply an enlarged link, or yoke, that is wide enough to be slipped over the knuckle, but I think it is open to objection on account of its weight.

Now I have a suggestion to offer in this line, and that is to have on top of the present knuckle a boss or horn over which to put an ordinary link, and pull the cars in that way. It strikes me that something of that sort would be very much better than anything attached to a car for doing the same work. I want to say again that I entirely agree, as I believe all the members will, that it is advisable to close up the opening in the pin hole, but I would like to hear some suggestions from makers of drawbars as to what provision they will make for pulling cars from places where they cannot be coupled, to a track where the coupling can be made.

Mr. E. E. Russell Tratman (*Engineering News*): There is, or was, on the market an M. C. B. coupler with a solid knuckle having neither slot nor pin hole, and intended specially for use in connection with the link coupler. It was called the "Perfection" coupler, and was introduced in 1892 by Stilger & Strosler, of Louisville, Ky. The pin holes were in the coupler head or drawbar, in the center line. To couple up with a link, the solid knuckle was swung back, and a pin dropped into the hollow coupler head, just as in an ordinary link and pin drawbar. It seems to have been but little used, and now to have gone out of use, as the Interstate Commerce report shows only nine cars equipped with the "Perfection" coupler in 1895–96–97, and none at all in 1898. Still the idea is worth considering in connection with the subject under discussion.

The President: We have a communication here from Mr. Rhodes, which I will ask the Secretary to read.

The Secretary: This does not relate so much to closing the slot in the knuckle entirely, as it does to shortening the distance between the opening of the lugs.

Lincoln, Neb., December 18, 1899.

Mr. Jos. W. Taylor, Secretary Western Railway Club,
667 Rookery Bldg., Chicago:

Dear Sir:—I notice with a good deal of interest that the subject of closing the knuckle opening in M. C. B. couplers will come up at the Western Railway Club meeting to-morrow afternoon.

I do not think any more important matter could be discussed. It is rather singular, that with all the discussions and reports and good work that has been done by the Master Car Builders in the matter of designs and specifications for the M. C. B. coupler, the subject of the distance between opening of lugs has hardly been discussed at all, and this opening remains without any material change from when the knuckle was first designed, and, moreover, without any specific dimensions

as to what the size should be. I have seen knuckles measuring at the opening, from 1⅞ inches up to 2¼ inches. No one takes any exceptions to such a variation, although it is a vital point in connection with the strength of the knuckle. Twelve years ago when the M. C. B. coupler for freight service was first being investigated, and when different classes of breakages were recorded and kept more accurately than today, knuckle lug breakages were the feature of all records and reports. This condition was doubtless aggravated at that time, owing to the greater variation in height of drawbars that then existed, and the fact that single lugs had frequently to take the entire strain of the work of the drawbars, whether it was buffing or pulling. This condition has been much improved since Congress adopted a law fixing the maximum height of drawbars at 34½ inches from the center of the bar to the top of the rail, and the minimum at 31½ inches. Even with these figures in the very excellent report presented to the Master Car Builders' Association in June of last year, the committee clearly shows (see Fig. 35, page 191, M. C. B. 1899, annual report), that with maximum and minimum height of drawbars coupled together, single lugs only will be coupled. I quote as follows from the report: "By the action of Congress the height of drawbars has been fixed at 34½ inches maximum and 31½ inches minimum. The line from which to measure has been determined by the Interstate Commerce Commission as the center line of the shank of couplers. It may, therefore, happen that a high car with its center line of drawbar 34½ inches above the rail, may have a head which is raised so that the knuckle extends six inches above the center line and three inches below. And to this may be coupled a low car with the head of the coupler dropped so that the knuckle extends six inches below the center line and three inches above. It will be seen from Fig. 35 that the contact faces of the couplers in actual engagement are limited to one lug of each knuckle, and instead of being six inches, as is intended by the law, they are reduced to three inches, and so are very liable to jump past each other on rough track." I do not think that any better argument could be presented for adding metal to these lugs. The committee not only shows that with cars conforming in height to the maximum and minimum allowed by law, there is danger on rough track of one car disengaging from the other by the knuckles passing over each other, but it also shows, beyond room for question, that single knuckle engagements do occur in service, and I do not believe that any one of us would say that *any single lug now made*, is strong enough and safe enough to stand *all the pulling and buffing of trains that freight cars are subjected to in service.*

I believe these couplers in a general way have more than met the expectations and the requirements of the railroad men, who, years ago through the late Mr. E. B. Wall, determined that the proper principle on which to make a safe coupling for car equipment was a design that consisted of coupling automatically in a vertical plane. Yet at a recent hearing before the Interstate Commerce Commission it was reported by one of the inspectors of the commission that 25 per cent of the M. C. B. couplers were out of order. I believe we will all agree that even if half this condition of bad order prevails, every effort must be made to produce a better showing. I believe it will not be disputed that knuckle breakages are still one of the greatest causes of failure with the M. C. B. coupler. The Master Car Builders' committee of 1899, has shown beyond dispute that living up to the law's re-

quirements we will have every now and then single lug engagements. Can there be any stronger argument for making a move to strengthen the single lugs, and is there anything that will strengthen them so much as adding a *quarter of an inch more metal to each lug?* We do not refer so much to the strongest and best knuckles now made. Perhaps their breakages in lugs may not be excessive. It will not be disputed, however, that there are scores of knuckles that will be materially strengthened with a little more material in the lugs. Why not allow this?

A year ago the C., B. & Q. railroad company ordered fifty steel knuckles cast with 1½-inch lug openings. These knuckles were distributed to the master mechanics of seven of the divisions of the C., B. & Q. with instructions to apply the knuckles to the way cars. The rules on the C., B. & Q. require all air brake cars to be fitted with M. C. B. couplers, and as all air brake cars are required to be placed in the front part of the train, it results in the link and pin bars getting next to the way car. It was, therefore, considered that these knuckles would be placed in the most objectionable part of the train, if there was any objection to their use. They have now been in service over a year, and I believe I am safe in saying that the first complaint has yet to be made to any officer of the C., B. & Q. railroad company. The reason that no complaint is offered, we believe, is very evident. The heaviest single D shaped link measures but 1¼ inches deep, the opening in knuckle being 1½ inches. There can be no question as to the ability to make a link coupling in such a case should it be required. Especially is this the case with the uniformity that now prevails and is required by law in height of cars. I believe some links are made as large as 1⅜ inches in diameter. It may be that such a link could not be inserted at the upset or welded end through a 1½-inch opening, but in such cases there is no reason why the middle of the link cannot be inserted between the lugs.

Personally, I believe the lug opening should be reduced to 1½ inches. I am satisfied that this can be done without any inconvenience and that it will add vastly to the strength of the knuckle. This opinion is based on a year's experience with fifty of such knuckles. I do not believe in our very quickly being able to adopt a solid knuckle. In case the opening recommended should not meet with the general prevailing idea, surely some of the railroads can adopt a knuckle opening of 1¾ inches, and refuse to accept from the manufacturers any more knuckles the openings of which exceed 2 inches.

Yours truly,

G. W. Rhodes.

President Hetzler: Mr. Haskell, we will be pleased to hear from you.

Mr. Haskell (C. & W. M. R. R.): There is one point that comes to my mind in connection with this; there are some places where we cannot handle our cars with the M. C. B. couplers, and where we have to use the links and pins in switching cars. We cannot switch cars on and off our car ferry with the M. C. B. couplers on account of curves being so sharp and flat, and therefore have to use links and pins. Now, if the slot and pin hole are closed, how

are we going to get the cars off the curve, especially if there is a sharp curve?

Some years ago when I was in Philadelphia, in walking up through the P. & E. tracks, I noticed some curves there where they were switching, and all the cars were coupled with links and pins. We stopped and watched them, and we asked why they did not use the couplers. They said there was not lateral motion enough between the draft timbers to allow them to switch the cars without doing damage.

President Hetzler: My experience has been almost entirely from an operative standpoint, and I wish to substantiate what Mr. Smith has said, namely, that we have a great deal of trouble in our yards making couplings with the M. C. B. standard automatic coupler, and it is often necessary, especially on sharp curves, to use a link between two couplers of this kind in order to handle the cars. I think this same condition holds true on every railroad in Chicago. This, however, does not lessen the importance of doing away with the slot and pin hole, and making some other provision, as by so doing the strength of the coupler will be greatly increased. I would like to hear still further discussion on this subject. Possibly some of the coupler companies have representatives present. If so, we would be pleased to hear from them.

Mr. A. J. Schevers (McConway & Torley Co.): I coincide with Mr. Luttrell's views in regard to removing the slot and pin hole, and I will say that we have some knuckles in service where we have the slot and pin hole removed; the knuckle is cast solid, but we have a lug on the top of the knuckle. Now there is seldom an engine or caboose that does not have switch rope; still, a switch rope is very many times unhandy to handle, and I believe with a small cable or a small sized switch rope with an ordinary link attached to the end, where you have to couple on an extremely sharp curve where it is almost impossible to couple an M. C. B. coupler, you can take the link, drop it in over this lug and pull your car to a point where the couplers will couple all right.

It will add over 25 per cent to the strength of the knuckle by removing the link slot and pin hole, and I am glad to see that the Western Railway Club is about the first club to take this matter up. I do not believe there is any more opportune time than the present to start in and make some provision for removing this slot.

It has also been suggested that a staple be attached to cars to which

you can attach your switch rope and pull the cars out. I am glad to hear this discussion brought up in the Western Railway Club as I think it will bear fruit. It has been talked of among railroad men in general, and there have been objections made to removing the link slot on account of not being able to take or pull the cars out of a sharp shop curve, but everybody must admit that it is not the M. C. B. coupler that is the cause of the breaking of the lugs or the knuckles; the links that are used in connection with the M. C. B. couplers have caused the damage to the knuckles.

Mr. G. W. Brown (C., M. & St. P. Ry.): My friend, Mr. Smith, made reference to certain makes of cars that he has seen in the past, that have rings on the corners. I think, perhaps, those cars may have been Pennsylvania, they may have been Baltimore & Ohio cars, but the occasion for the use of those rings arose from certain conditions existing on those roads many years ago, where they switched with horses instead of engines.

The discussion on the closing of the slot in the M. C. B. coupler is all right, and it is opportune; it is going to come. When the link and pin disappear there will be no further need of the slot, but just how to pull the cars that are in the yard off the curves we do not know today. Discussion may show some good way, but until that time comes, and we may trust American ingenuity to show us the way, the switchmen will take one brake chain, and if one brake chain is not enough they will take two, and they will get those cars off the curve. It appears to me that with the coming knuckle the problem will be, in some manner to reduce the excessive friction that now exists, and prolong its life by a hardened face. As I say, those things will be the result of development, and the discussion of today will be the cause of development in the future.

The President: If there is no further discussion on this subject it is in order to adjourn.

Adjourned.

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May	26 "	November	12 "
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March	10 "	October	1 "
April	7 "	November	39 "
May	15 "	December	188 "
September	5 "	1898, January	133 "
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September	26 "	February	128 "
October	36 "	March	47 "
		April	32 "
		May	12 "
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Mr. S. F. Patterson, Secretary: Proceedings of the Eighth Annual Convention of the Association of Railway Superintendents of Bridges and Buildings, held in October, 1898.

Baldwin Locomotive Works: Record of Recent Construction, Nos. 15, 16 and 17; also Circulars No. 1 to 11, inclusive.

Mr. Charles C. West: Sibley Journal of Mechanical Engineering, for 1899-1900.

Mr. John P. Meany, Manager: Copy of Poor's Manual of Railroads for 1899. Thirty-second Annual Volume.

Mr. J. W. Taylor, Secretary, Proceedings Master Car Builders' Association for 1899, Vol. 33.

Mr. J. C. Whitridge: Photograph for framing of new locomotive for North Eastern Ry. (England.)

Mr. Edward A. Moseley, Secretary: Statistics of Railways in the United States. Eleventh Annual Report for year ending June 30, 1898.

Mr. William Forsyth. Bibliography of Railways for Sept. and Oct., 1899.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

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Club meets third Tuesday in each month, except June, July and August.

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THE regular monthly meeting of the Western Railway Club was called to order at 2 p. m., Tuesday, Jan. 16, 1900, in the Auditorium Hotel, Chicago. President H. G. Hetzler in the chair.

Following are the names of those who registered :

Akerlind, Geo. A.
Anderson, Geo. T.
Anderson, Thos.
Angell, F. R.
Baldwin, Walter H.
Bayley, R. W.
Bischoff, G. A.
Bolton, T. E.
Bradeen, J. C.
Brazier, F. O.
Breckenridge, Prof. L. P.
Broman, J. G.
Bundy, C. L.
Card, C. W.
Clark, F. H.
Cockfield, Jos.
Collier, F. P.
Condron, T. L.
Conger, C. B.
Cook, A.W.
Cormack, Wm.
Crane, Chas. A.
Crosman, Walter D.
Cushing, G. W.
Dean, Nat. C.
Deems, J. F.
Delano, F. A.
Doyle, Edw.
Drake, E. A.
Eames, E. J.
Eddington, W. J.
Edgar, W. H.
Farmer, G. W.
Feldman, Prof. A. M.
Fitzgerald, J. J.
Forsyth, A.
Furry, Frank W.
Goehrs, Wm. H.
Goss, Prof. Wm. F. M.
Graham, J. A.
Hatswell, T. J.
Hedrick, Elias
Henderson, Geo. R.
Henry, C. S.
Hetzler, H. G.
Hill, Jas. W.
Hone, A. C.
Hornish, F. W.
Hubbell, Ira C.
Jefferson, E. J.
Judson, H. D.
Keegan, J. E.
Keeler, Sanford
Kerr, Prof. C. V.
Kirby, T. B.
Kirby, W. S.
Lane, F. W.
Luttrell, J. W.
McAlpine, A. R.
MacBain, D. R.
Mackenzie, John
McMaster, J. C.
Manchester, A. E.
Marshall, W. H.
Medway, John
Molleson, Geo. E.
Morris, A. D.
Noble, L. C.
Opie, J.
Otis, Spencer
Paxton, Thos.
Perry, A. R.
Raidler, W. P.
Reilly, T. S.
Rhodes, G. W.

Riddell, Chas.
Rogers, M. J.
Royal, Geo. Jr.
Sanborn, John G.
Scales, Richmond P.
Scott, G. W.
Shea, R. T.
Shields, H. S.
Slater, Frank
Smith, Frank P.
Smith, R. D.
Snow, T. W.
Soule, R. H.
Spear, F. R.
Sprague, W. T.
Stewart, S. C.
Stocks, W. H.
Sullivan, C. L.
Taylor, J. W.
Thurtell, B. W.
Tratman, E. E. Russell
Traver, Wilbur H.
Van Dervoort, W. H.
Wakeman, C. J.
Whitridge, J. C.
Wickhorst, M. H.
Wilcox, L. A.
Williams, J. C.
Wilson, H. M.
Woods, E. S.
Woods, J. L.
Zeleny, Frank

President Hetzler: The minutes of our last meeting were sent to the members, and, if there are no corrections, they will stand approved as published.

I will ask the Secretary to read the names of new members who have been approved by the Executive Board.

The Secretary then read the following:

Chas. McShane, Griffin & Winters, Chicago.
Chas. Henry Davis, Consulting Engineer, New York.
A. W. Gillespie, C. C., P. A. Dept. K. C., P, & G. Ry., Kansas City, Mo.
H. D. Luse, Rd. House Machinist, Union Pac. Ry., No. Platte, Neb.
H. A. Callan, Latrobe Steel Co., Chicago, Ill.
W. B. Wheeler, Devoe & Raynolds Co., Chicago, Ill.
Jno. Gill, M. M., C., R. I. & P. Ry., Trenton, Mo.
E. A. Drake, Drake & Wiers Co., Cleveland, Ohio.

President Hetzler: Under the head of new business, I will ask our Secretary to read the action of the Board of Directors.

The Secretary then read the following:

At the meeting of the Board of Directors, held today, it was decided that the restrictions on the newspapers, in regard to not publishing any of our papers and the discussions thereon until after the Proceedings were issued, should be modified to the extent that the technical papers be permitted to handle the matter in any way they see fit, after the papers have been presented and discussed at the Club meetings, with the understanding that the papers and discussions are subject to the revision of the members presenting them.

President Hetzler: We have with us this afternoon Professor Goss, our second Vice President, who has been absent for a number of months. While we have been obliged to forego the pleasure of having him with us, he has been enjoying himself in a trip abroad, and I take this, our first opportunity, to welcome him and to ask him to share with us his pleasures by telling us of them.

Prof. W. F. M. Goss: It is a pleasant thing to be back once more with the Western Railway Club. In all my traveling I have not been far removed from its influence, for in England, and in France, and in Germany, I heard its proceedings referred to, and its work spoken of, in terms of highest commendation. One of the surprises which came to me in Germany will, I think, interest you.

My journey had brought me within forty miles of Chemnitz, which is the location of the great Harmann Machine Works, one of the largest locomotive manufacturing establishments in Germany. Desiring to see these works, and having no letter of introduction, I ventured, with some feeling of trepidation, to address a note to the "Director in charge of the Locomotive Department," asking if I could be allowed the courtesies of his department. Imagine my surprise and pleasure upon receiving a reply from Director Brückman stating, "I greet you as a member of the Western Railway Club, and shall be more than glad to welcome you to our works." I afterward learned that the writer was one of our visitors during the Fair in '93, and that in the course of his visit Mr. Brückman had become acquainted with many of our engineers, had qualified as a member, and has ever since rejoiced in his Club privileges. I need not say that I was royally entertained at Chemnitz, and I do not for a moment forget that for these courtesies I am indebted to the Western Railway Club.

Mr. Brückman was fortunate in being able to give his trip to America the form of a wedding journey, and both he and Mrs. Brückman are still enthusiastic in their rehearsal of courtesies received on that occasion. He asked that I extend his compliments to such friends, and I am sure they are many, as may still remember him.

My going away appears to have had a pronounced effect upon the membership of the Club. No sooner had I sailed than members who were located west began moving east, and a little later, eastern members began to locate themselves west, and so on throughout the nine months of my absence. It may be, however, that it was not my absence, but the worth and efficiency of the Club, which accounts for this state of effervescence among its members. At all events, I cannot refrain from expressing regret that some who were here long ago to greet me when I was new to the Club, are now so far away as to make it unlikely that we shall often see them at future meetings. But I am glad that the picture has a reverse side, and that upon it

appears a goodly array of new workers, in the possession of which any club may well be proud.

Concerning my trip, I may say, briefly, that I had a good time. By the courtesy of friends at home, and of new-found friends abroad, I lacked nothing. I went wherever I wanted to go, and saw whatever I desired to see, a statement which implies, in many cases, privileges not often granted. To these friends, therefore, I owe much.

It was a source of great inspiration, and of pleasure, to meet those who are recognized leaders in the engineering progress of several of the great European countries and to see railway and manufacturing establishments which they count as among their largest and best. Each day brought its opportunities and yielded its pleasures. But the keenest delight was, after all, in the home coming, and is now in the greetings of this company; for here, in this very Club, are friends in whose strength of character, affection and sympathy, is inspiration such as cannot be drawn from beyond the sea.

And so it is that I am glad to be back. Glad to assume old duties, and I shall be doubly glad if, as time goes on, I shall be found of service to the Western Railway Club. (Applause.)

President Hetzler: The paper for discussion this afternoon is by Mr. F. A. Delano, "What Does it Cost to Run Trains at High Speed?" This is a very interesting paper; a subject in which every department of the railroad is interested, and we should certainly have a very thorough discussion. I will ask Mr. Delano to review his paper, and make such remarks as he desires.

What Does it Cost to Run Trains at High Speed?

By F. A. Delano

A good deal has been said and written in the last year or more about the phenomenally high speed made in this and other countries, and superintendents of motive power, mechanical engineers, and locomotive builders have all pointed with justifiable pride to the records made by particular engines. The writer was recently asked by a superior officer to tell at short notice, how much more it cost to operate a train scheduled at a very high rate of speed, than a train at a moderate rate of speed, and after studying the matter over carefully for some hours, came to the conclusion that an answer to the question was so complicated a one that it could only be made in general terms.

When asked by the officers of the Western Railway Club to write a short paper at short notice, I could think of no question which needed an answer so badly, and no question which would be of more general interest to railroad and mechanical men than the question of the cost of running high speed trains. In a general way the subject has been pretty constantly in the minds of operating officers of railroads, but when we come to answer the question in figures, how little data is at hand to assist us?

For convenience we will group these items of cost of operation, which are increased with high speed as compared with moderate speed service, under the following headings:

First—Increased fuel consumption.

Second—Higher grade or standard of machinery, material and service required for extra fast trains.

Third—Increased wear and tear, cost of maintenance of machinery, permanent way, etc.

Fourth—Increased risk of accident by breakage of machinery, injury to track, etc.

Fifth—Increased risk of accident, such as collisions with other trains, and risks taken to avoid collisions.

Sixth—Delay to traffic on account of keeping the road clear.

We will consider each of these headings in sequence.

First: The ordinary formulæ for train resistance would indicate that the cost of operating a train at, say 60 miles per hour, as against 30 miles per hour would entail an increased fuel consumption of something like 62½ per cent. [This is determined by the Baldwin Locomotive Works formula: $R = 3 + \frac{1}{6} V$.] The figures, which I have been able to get at short notice, indicate that the increased fuel consumption per car or ton is much greater than this, and certainly proportionate to the speed. This is largely due to the fact that a locomotive cannot be operated as economically at higher speed, and that if designed with a special view to economical operation at very high speeds will have a very diminished tractive power. By way of illustration, I may cite a very interesting series of indicator cards I recently saw, taken from an engine to determine the steam distribution in the cylinders at the same cut-off, but at speeds varying from 20 to 57 miles per hour. Although the cards were considered as making a most satisfactory showing, the drop in the

M. E. P. was astonishing. [The figures showed a drop of 42 per cent in M. E. P. for an increase of 30 M. P. H. in speed.] A more familiar way in which the same fact is forcibly brought to our attention is the recollection that a class of engines which formerly handled trains of ten to twelve cars successfully on many of our trunk lines ten years ago, is now discarded for branch or light service, and engines of more than twice the power do not handle as long trains. Obviously the difference is due to the enormous increase in the demand on engines in the way of speed. Furthermore, in comparing engines of today with those of ten or fifteen years ago, it will be noted that the increase in boiler capacity has been much greater than the increase in cylinder dimensions.

Second: In extra fast service, no expense, one may say, is spared to prevent breakdowns, detentions, or failures of any kind; even the waste which is put in the oil boxes of cars and engines is of a special quality; the journals are burnished; the brasses are especially scraped or machined; the coal which is put on the tanks is selected coal, broken in advance so that the firemen will not be obliged to break it. The locomotive itself is looked over by the best mechanics, and the master mechanic gives a large share of his thought and attention to the condition of the engines and cars in such trains. In the superintendent's and despatcher's office in the same way, especial attention is given to avoid delays; in the maintenance of way department, from the roadmaster to the section man, the constant thought is to make the track safe for this special service. In other words, the entire character of the service is keyed up to a necessarily high pitch, which while accruing in a measure to the benefit of the other service, nevertheless adds expense which it is impossible for any man to more than guess at. It is, of course, unnecessary to add that the best locomotive and car equipment is used in such trains.

Third: The added cost of wear and tear of machinery, rolling stock and track is noticeable. It has often been noted that on a new piece of track a heavy engine hauling a high speed train will often do an immense amount of damage in throwing out of line and surface, a track which has stood up satisfactorily under a number of heavy though slowly moving trains. With old track in good condition the difference in the effect of high speed as compared with slow trains, is of course very much less noticeable, but that the difference exists nobody of experience doubts. The best evidence of the added cost of wear and tear of the machinery is shown in the records of engine failures which are kept by many railroads. It has been found that by keeping these failures divided between freight and passenger service, the fact is disclosed that the failures of engines in passenger service are in much greater ratio to passenger train mileage than the failures in freight service, and this in spite of the fact that the best motive power equipment is used in passenger service. A still further analysis of these failures shows that an overwhelmingly large proportion of the failures in passenger train service occurs in special fast passenger and mail trains, the failures in light and slow passenger service being almost *nil*.

Fourth: In spite of the care that must be used, the risk of accidents, breakage of machinery or failure of track and structures cannot be lost sight of. What this risk is worth in terms of an insurable quantity would take an actuary with statistics covering years of actual performance to determine. Eternal vigilance has sufficed to reduce accidents in high speed service to a comparatively low figure, but

how terrible in consequences such accidents can be is too well known to railroad men to dwell upon.

Fifth: The risk of accidents to other trains is also an unknown quantity which is most difficult to determine. It may operate in several ways. The effect of a collision, it is known, varies as the square of the velocity, but it is not only in collisions that the risks are great. There are many other small and elusive ways in which this item operates. Take the case so familiar to railroad men, who have had experience in the engine or train service, of a freight train trying to get in on a side track to clear some special train. There may be a hot box on the train requiring attention, but the engineer and conductor looking at their watches see that they must hurry or have an explanation to make. The box is allowed to go with perhaps scanty attention and a risk is taken which once in a while results fatally. Accidents from collisions of trains are fortunately rare on good trunk lines, but the character of the service required to avoid them is of the highest class. There would be small necessity for the expensive block and signal systems were it not for the excessively high speed trains. Divisions of railroads on which such trains are not run, are, we know, successfully operated without them, and the expense of all such safety appliances does not enter so much in the first cost as in the cost of maintenance, renewal, and the wages of employes attending them.

Sixth: The delay to other traffic due to high speed trains while a most difficult factor to determine, is to my mind perhaps the most serious one. I remember reading an article by Mr. Ely, now chief of motive power of the Pennsylvania System, which appeared in *Scribner's Magazine* for March or April, 1892, (I have been unable to put my hand on the magazine) in which he discussed, as I recollect it, in a very interesting way, the possibility of operating trains at excessively high rates of speed. It was at a time when there was more or less discussion as to whether it would be possible to build a locomotive that would run 100 miles an hour and whether, when it came to making such high speed as this, electric motors would not displace locomotives. The point that Mr. Ely made was that while it might be entirely feasible to design a locomotive to make such a speed, the real difficulty was a transportation difficulty. He showed by a number of illustrations that it would practically mean an independent track, and, of course, in figuring the cost of operating such a train, the interest on the value of the track and right of way to which it must have exclusive use would have to be taken into consideration.

It has been pointed out a good many times by practical railroad men that the way to do a maximum amount of business over a piece of railroad is to have the speed of all trains as nearly uniform as possible. The most familiar examples which we have in our daily lives, of the carrying capacity of a railroad moving its trains at a relatively slow but uniform speed and at frequent intervals, are the street car lines and elevated roads. When we read the statistics of business done by street car companies and elevated roads on holidays and compare them with the numbers handled by steam roads we are sometimes astonished at the difference. The steam road handling its long trains at infrequent intervals cannot begin to do the business of the street car line or elevated road with its frequent trains following each other even at a much more moderate rate of speed.

A fast train following a slow one soon catches up with it or, as the expression goes in railroad parlance, "runs over it." The slow train must take a side track.

This takes time, and furthermore an allowance or clearance must be given between the trains to provide for safety. Reversing the case, a slow train following a fast one, lags behind it and leaves a big gap, during which time the railroad is unoccupied, or, summing the case up, the high speed train in just the ratio which its speed exceeds that of the other train, makes a gap in front and behind it, during which time it has the exclusive use of the track. Take a simple illustration of three stations, "A," "B" and "C" on a railroad, located 30 miles apart; a train leaving "B" at 30 miles an hour is caught by a train leaving "A" at the same moment but running at 60 miles an hour just as the two trains reach "C," but as this would not be a practical way to operate, an allowance must be made to permit the slow train to side track and also provide a safe interval of clearance between the trains; hence it is obvious that the slow train leaving "B" must leave the full amount of time for side tracking and clearance ahead of the fast train leaving "A." Cases such as this and much more complicated, especially in the case of a single track railroad, are a mere commonplace in railroad operation, and in many cases there is a much greater divergence in the speeds of trains considered than in the illustration suggested.

I remember that at the time a special fast train was put on an important trunk line it was said that the running of the train was fully justified by the fact that the train earnings were more than twice the average passenger train earnings of the road, but many shrewd and conservative men said that the true expense had not been fully considered, and it was further pointed out as an actual fact the passenger and freight service of the road was, to a great extent, paralyzed by the fast special train. It is quite certain that it must have impaired the capacity of the railroad to handle business.

There are other ways too indefinite to classify, in which especially fast service has increased the cost of transportation in general. It has led to the construction of larger and more powerful engines, and has educated the public as well as railroad men to the point where the old fashioned speed of 20 to 30 miles an hour is considered slow even for freight. More powerful engines have, of course, brought about some economy in greater tractive power, but the greater power and greater ability to handle trains at speed has encouraged to some extent a laxness in engine, train and yard men. How often one hears the expression when a passenger or freight train leaves any station behind time, "Oh ! that is nothing, we can easily make that up." Every railroad officer knows that the general speed of all trains has greatly increased in ten years; few of them know how rapidly many of their trains are run between stations.

Steam railways have done most to educate the public to this demand for speed, but there have also been other forces at work. In the domain of urban and interurban transportation there has been an astonishing change. Cable cars which once seemed rapid as compared with horse cars are now thought slow in comparison with electric cars. What the limit of speeds will be, and whether it is best for the human race that the speeds of transportation be increased is not within the province of this paper. The point I wish to enforce is, that speed costs heavily, just how much I am not prepared to say. The general superintendent of an important trunk line recently gave the cost of operating an extra fast train as $2.00 per train mile. How this figure was reached I do not know, but, at a guess, I should say it was

none too high. However, I feel that I must close my paper with the question expressed in the title still unanswered, and with the hope that some one else better qualified can answer it.

Mr. F. A. Delano (C., B. & Q. R. R.): Mr. Chairman, and gentlemen—I ought, perhaps, to begin with an apology for the briefness and insufficiency of this paper on so large a topic, but the only explanation I will make is that I say exactly the truth when I state that I got it up at very short notice, and to fill a gap which appeared to exist.

I think, in considering this subject, as we will, from a mechanical and engineering standpoint, it is well to remember what the railroad exists for and what we, as servants of railroad companies, are hired to do. I think you will all agree that the work of a railroad man is to try to make the *difference*, between the income of the road and the outgo of the road in expenses, as great as possible. Now the work of the railroad is so great that it is necessarily differentiated into a great many different departments and sub-departments, so that we sometimes lose sight of that broad general fact. Bearing that in mind, I want to ask you whether it is not a fact that the greatest advance in recent years, in general manufacturing, has not been due to learning just what the things cost? If you are producing something in a shop, whether it is a railroad shop or ordinary manufacturing shop, the first thing you must do, before you can make an improvement, is to find out what it is costing you to produce it. Of course, a great many elements enter into the cost of production of anything, and it is often a very difficult question to answer, and in the same way in the manufacture of transportation, we have a great many complicated questions to determine. Nobody has ever really shown what it costs to carry a passenger, or to carry a ton of freight; all that we have been able to do is to show what the *average* cost is. Now the question I ask in this paper, "What does it cost to run trains at high speed?" might be dismissed by a great many by saying, "Well, there are so many elements in the question that it simply cannot be determined; it is unanswerable." It seems to me that we ought, at least, to get together all the data we can, bearing on the subject, with a view of approximating an answer. With that in view, I divided the subject under six headings, as you will see, and, testifying to the haste with

which I got up the paper, I will say that one or two other items of expense have occurred to me since the paper went to press.

Those I considered are, (1) the increased fuel consumption ; (2) the higher grade or standard of machinery, material and service required for extra fast trains; (3)increased wear and tear, cost of maintenance of machinery, permanent way, etc.; (4) increased risk of accident by breakage of machinery, injury to track, etc.; (5) increased risk of accident, such as collisions with other trains, and precautions taken to avoid collisions ; (6) delay to traffic on account of keeping the road clear.

I will not attempt to read the paper. I will explain one thing in the first section, because the question may occur to you that did to a gentleman sitting near me. I took the formula for the train resistance which is used by the Baldwin Locomotive Works, and which I think originated with Mr. D. L. Barnes, formerly a member of this Club, and which gives the lowest figure for train resistance, very much lower than Mr. D. K. Clarke's, and for that reason can be assumed to be ultra-conservative. That formula shows that the train resistance per speed of sixty miles an hour, as compared to thirty miles an hour, increases 62½ per cent, that is, of course, as you understand, resistance in pounds per ton. Now, as I state in the paper, there is a still further loss in fuel economy due to the inefficiency of the engine, the steam in the cylinder. I took that to be 42 per cent, a figure taken from some recent indicator tests made for another purpose, where the engineer who made the tests found, in taking cards at the same cut-off, but for speeds varying from twenty to fifty-seven miles per hour, that there was a steady decrease in the mean effective pressure, and in the ratio of the mean effective pressure to the boiler pressure.

The two other items not mentioned in this list which I thought of, since writing this paper, I will simply mention in the hope that somebody else here will dwell on them a little more at length. One is the fact that in order to make an engine for high speed service we must have large boiler capacity, and since, to carry that large boiler we do not want many drivers, but want an engine with large wheels or, as we say, a long-legged engine, hence, we must have, of course, a very high load per wheel or per axle. A high load per wheel or per axle means high strains on bridge structures, structures of all kinds, and on the track. That means in just proportion an increased capi-

tal invested, not only in locomotives but in more expensive bridges and heavier rails, etc.

The other item which I am led to speak of, in recalling a discussion of the street railway men in this city (I do not remember the name of the association), is that of the dead weight carried per paying passenger or per ton of paying load. Going very cursorily into this matter, I am told that the figures showed that in the electric street cars the load per passenger varied from 750 pounds to 1750. In railroad operation I find that the dead load per ton of paying freight is about three to one, that is, four tons carried for every one ton of paying freight. This is an average for a large road west of the Missouri river. In passenger business, I figured out a number of cases and it shows that something like four to five tons per passenger are carried on important trains, and in special mail trains there are something like twenty-five to thirty tons of dead load hauled for every one ton of mail.

The only reason I mention this is, that if we are accelerating the service, we find at once that we must increase the weight of the motive power at the head end of the train, and at the same time decrease the weight of the train behind the engine; in other words, the ratio of live load to dead load is diminishing in two ways: (1) by having to use a heavier and more powerful engine to give the required boiler capacity; and (2) by having to decrease the train behind it.

President Hetzler: We have one or two letters here from different members which I will ask the Secretary to read.

The Secretary then read the following:

Detroit, January 15, 1900.

Joseph W. Taylor, Esq., Secretary Western Railway Club, Chicago, Ill.

Dear Sir:—Your circular announcing the subject to be discussed tomorrow, January 16, comes to my desk for consideration this morning. There is no one, I think, that will dispute the fact that it will take more fuel and cost more to run a train sixty miles per hour than it does to run one thirty miles per hour. There are conditions, however, that obtain on most all roads, where fast running is more economical than slow running. Not many years ago it was thought not economical to run freight trains faster than fifteen or eighteen miles per hour, and on the road with which I am connected it took in those days from twelve to fifteen hours to run over a certain division. With sharper competition and quicker time demanded the increased speed of these trains to twenty-five and thirty miles an hour does not show any increase in expense for fuel than it did at the slower rate of speed, because an engine now makes the run in from six to nine hours, burning fuel a number of hours less, though they consume more while they are running.

It will be seen that a very much smaller investment in locomotives is required to do the same amount of work. As said in the report, steam railroads have done the most to educate the public to this demand for speed, just as they have to the demand for large cars, each management installing such service and size of cars for benefits that would accrue by so doing, instead of getting together and making a point beyond which they would not go. Certain it is, that we are face to face with these conditions and it would be hard to retrograde, but action might be taken to hold the conditions as they exist now, until some greater power than the use of steam shall make it possible to inaugurate better speed with economy.

Yours truly,
ROBT. MILLER,
Supt. M. P. & E.

CHICAGO, January 16, 1900.

Mr. Jos. W. Taylor, Secretary Western Railway Club, 667 Rookery Bldg., City.

DEAR SIR :—In response to your kind invitation to take part in the discussion of Mr. Delano's paper on the cost of running high speed trains, I wish to say that I had hoped to be able to be present at the meeting this afternoon, or at least to submit a formal discussion of the paper, in writing, but the time at my disposal has not permitted either. My article on "High Speed," to which you refer, was written after some study of the subject, and as it was intended to cover the ground generally, I suppose I could expand on many of the points taken up. The chief aim in this article, however, was a discussion of methods of attaining higher speeds than are at present in vogue, whereas I suppose Mr. Delano's paper was intended to arrive at the increased cost of running such high speed trains as are now in service.

The outline which Mr. Delano presents on the increased cost of high speed trains covers the ground, and I think the only question now considered in connection with the proposition of cutting down the time of scheduled trains is that of increased cost. In respect to the third heading, namely, the increased wear to track caused by such trains, the point is undoubtedly well taken. A very large part of the expense of track maintenance goes for surfacing, or for tamping the ties to an even surface, to be more specific. Now as between trains running at moderate speed and trains running at high speed, there is every reason to believe that the high speed trains are much more severe on track surface, or as a cause of track settlement. In fact, we have some evidence on this point produced by recognized authority from careful experiments. It is familiar to most railroad men that Mr. P. H. Dudley has an instrument called the "stremmatograph," for measuring the strains in the flange of a railroad rail under trains at speed, and the data obtained from the same train running at different speeds have been compared to ascertain the effect of increase of speed upon the strains in the rails. In one case, two experiments were made on track laid with 80-pound rails with an engine weighing sixty tons (exclusive of tender), and the results obtained indicated that an increase of speed from two to ten miles per hour increased the strains in the flange of the rail about 14 per cent. In this case, an average was taken of both tensile and compressive strains, under and between all of the truck wheels and drivers. In other experiments it was shown that as between passenger

engines of about the same weight, running over track laid with 80-pound rails, an increase of speed from twenty to forty miles per hour increased the maximum rail stresses under the engine drivers from 14,000 pounds to 31,400 pounds per square inch of metal; which is to say, that doubling the speed more than doubled the straining effect on the rails. It is reasonable to expect, therefore, that train speeds of sixty or seventy miles per hour must produce pretty heavy strains in rails of ordinary weight.

Increased strains in the rails are, of course, an indication of increased depression of the track, continual repetition of which means increased rate of track settlement, which, of course, calls for increased expense in track surfacing. On this line, I think it may reasonably be assumed that high speed trains must increase the wear and tear of track, and the consequent cost of track repairs very considerably.

It is also likely that economy of track maintenance on any road where a considerable number of high speed trains are run calls for a heavier rail. The increase of weight in rolling stock during the past fifteen years has brought about an increase in weight of rails, from fifty-six or sixty pounds per yard to the rails in common service at the present time, weighing eighty pounds per yard and heavier. So far as maintenance of way men are concerned, it is to be hoped that increase in weight of rolling stock will soon reach its limit; and, possibly, there may be good reasons from other standpoints why further increase is not desirable. As to increase of speed, however, there seems to be no barrier other than the question of making it pay, and after the effects of high speed on track are better understood, it may be found advisable to further increase the size of rail sections.

Another respect in which it would seem advisable to increase maintenance of way expenses in deference to high speed trains is in the matter of track inspection. On eastern roads, when rails were lighter, the track walking system was quite commonly in vogue, and it was expected that, as far as possible, each track walker should get over his beat immediately preceding the arrival of each fast passenger train. As heavy rails have come into use this system has been abandoned to some extent on eastern roads, while on western roads the system never succeeded in coming largely into practice. Considering the increased difficulty of stopping high speed trains within a desired distance, in the presence of danger, it would seem that, for at least these trains alone, if for no other, the track should receive careful inspection by a regular system of patrolling. While the expense of such a system is heavy, and while defects in a well maintained track may be of seldom occurrence, the system should, nevertheless, receive careful consideration in any estimate of the expense of running high speed trains with the highest regard to safety. It will be recalled that railroad trains are frequently wrecked by running into cattle on the track, and by washouts caused by summer "showers," the severity of which are sometimes underestimated by the section foreman. With a regular system of track patrol, greater vigilance can be exercised in keeping stock off the right of way, and in all kinds of weather the inspection of the track is maintained. The necessity of abolishing crossings with highways at grade, or of stationing flagmen at dangerous crossings is well understood, for it is known that the frequency of colliding with teams at grade crossings increases greatly with even a moderate increase in the speed of trains.

W. M. Camp.

Mr. G. R. Henderson (C. & N. W. R. R.): I think Mr. Delano's points are all very well taken, and I do not intend to dispute any of them, but I thought it might be somewhat interesting to enlarge on some of the ideas. At the bottom of the first page he speaks of the fact "that a locomotive cannot be operated as economically at higher speed, and that if designed with a special view to economical operation at very high speeds will have a very diminished tractive power."

Now in regard to increased fuel consumption, Mr. Delano has spoken of the increased consumption and the resistance, which, of course, we all know, but there is another increase of fuel consumption of which I do not see any notice in this paper, and that is, if we take a rate of combustion for one and one-half pounds of coal per square foot heating surface per hour, we will get, with average fuel in this section of the country, an evaporation of seven pounds of water per pound of coal. If we increase this rate of combustion to three pounds per square foot of heating surface per hour, our rate of evaporation is reduced to five pounds of water per pound of coal; or, if we say, that we will burn coal at the rate of one pound per square foot of grate surface per hour, we will have an evaporation of eight pounds of water or a steam production of eight pounds per square foot of heating surface per hour; but if the rate of combustion is increased to three square feet of heating surface per hour, then we obtain about fifteen pounds of steam per square foot of heating surface per hour, or to double the rate of evaporation per hour we have to burn three times the amount of coal. Of course, the distance over the road is doubled, owing to the increased use of steam, so that the actual consumption of coal is 50 per cent increase per mile, due to the uneconomical rate of combustion, and 62 per cent increase due to the increased resistance, as shown by Mr. Delano's paper. By combining these two increases we find a total increase of 1.40 per cent in the amount of coal per mile (or per ton mile) just on account of doubling the speed; or, in other words, when we double the speed we burn about two and one-half times as much coal in the same distance.

Now, in regard to the second paragraph, relating to the expense of material, etc., I will say that we have, in the last month, had difficulty with our high speed trains on account of poor coal—in regard to which I believe there are others in the same boat, as I have heard complaints on all sides—but in order to get suitable coal in our ten-

ders we have gone into the practice of "forking" the coal; in other words, we obtained large forks, something like pitchforks, with the prongs about an inch or an inch and a half apart, and when we get coal that is very fine we fork it out and shake it before it is put on the tender. Of course, the high speed engines get the coal that is forked, and the freight engines take what is left, and there is a great deal always that is left. Before we got those forks there was so much trouble with the coal that we actually had to adopt the practice of putting three men and a car of coal alongside the tender, to pick over the coal and put it in by hand, so as to eliminate the slate and dust.

Another point which comes to my mind is the increase in the oil used on these fast runs. I do not mean to say that there is any actual necessity for it, but, as a matter of fact, on some of our particularly fast runs, we notice that the men use from two to three times as much oil as they do on the ordinary runs. They have not been stinted, particularly, and so they have not had much trouble in hot bearings, but it shows the tendency to use greater quantities of oil on fast runs.

Referring to the third paragraph, there is another point that the motive power officers recognize in regard to high speeds, and that is, that if there is any delay, a slow speed train can very easily make up the time, but if a high speed train loses five minutes and tries to make up the time, it is then that engine failures commence, and we are asked at the end of the month why we have so many engine failures.

In regard to the fourth paragraph, the extra danger of collision, of course we all know, and I think it is mentioned in this paper that the effect of a collision is in proportion to the square of velocity. Now the difference between the work done by the engine going thirty miles an hour and the engine going sixty miles an hour, can be, perhaps, put in this way: At 30 miles an hour the momentum of train is sufficient to raise it 30 feet, vertically, and at 60 miles an hour the momentum would raise it to 120 feet. By considering the amount of destruction or damage which would be done by dropping the train vertically 30 feet and 120 feet respectively, we will get an idea of the probable damage due to a collision at these two speeds. That gives a pretty good idea, I think, of the comparative damage done in a collision of different speeds.

The fifth paragraph is a pretty clear determination of cases that exist in our practice.

In the sixth paragraph there is one point that could have attention called to it with some interest, and that is the great number of trains that have to be sidetracked to make room for the high speed train, is going to increase the consumption of coal on these trains, which will be due principally to the high speed trains. Now the point is this: If we have a certain rate of coal consumption per ton mile, on a train, and we can make a fair run of, say, twenty to twenty-five miles an hour with that train at a low rate of coal consumption, if that train is to be laid up on the sidetracks for the right of way of this high speed train, we will have to keep fire in the engine, and, of course, burn coal while she is lying on the sidetrack, which brings in no return, and then when we try to make up the time, if we do attempt it, we will have to burn much more coal to get a higher rate of speed, so it doubles up on the coal, not only in the time she lays there, but in the extra attempt to make up the time. So we will see there are a great many factors that enter into the higher cost of high speed trains.

Mr. J. W. Luttrell (Illinois Central R. R.): I am of the opinion that Mr. Delano made a remark that he did not intend to, and that is, that it was the duty of railway employes to make the income and outgo as large as possible. I believe he intended to say, to make the income as large as possible, and the outgo as small as possible.

Mr. Delano: I said to make the *difference* as large as possible.

Mr. Luttrell: But you did not divide it up and say which should be the big end of it. I do not think there is any questioning the fact that Mr. Delano has pointed out, to the satisfaction of all concerned, that it costs very much more to operate high speed trains than slow speed trains, and Mr. Henderson has fully endorsed the stand that Mr. Delano has taken.

At the conclusion of Mr. Delano's paper he makes this remark: "I feel that I must close my paper with the question expressed in the title still unanswered, and with the hope that some one else better qualified can answer it." Now there is no doubt but what this is a very important matter, and I do not think there is any member of this Club better qualified, or that has a better opportunity to answer this question than Mr. Delano has, and I believe that the Western

Railway Club, and the railways generally, would be largely interested and benefited by Mr. Delano's continuing the subject, and giving us some specific figures.

MR. F. H. CLARK (C., B. & Q. R. R.): I had occasion, some time ago, to consider the effect of high speed on the cost of hauling trains in passenger service, and met with the same difficulties that Mr. Delano mentions in his paper in arriving at satisfactory results, that is, I found that there are a great many elements entering into the problem that can not be accurately weighed.

I took the matter up, however, and made a comparison between two trains running in the same direction over a division of about 190 miles, one averaging a little less than 7 cars, at a speed of 31⅓ miles an hour, deducting 10 minutes lost at one stop, 18 stops in all; the other, a train averaging a little less than 4 cars, at an average speed of 48 miles an hour, with 7 stops.

I took into consideration, for a period of six months, the amount of fuel used, the wages of engine and train crews, and the cost of engine and roundhouse service, and found, so far as the above items are concerned, that the cost per car mile is about 77 per cent greater for the 4-car train, at 48 miles an hour, than for the 7-car train at 31⅓ miles an hour. In order to check up my figures for mileage and coal consumption, I included two other trains in my calculations, and have covered these figures in a table, which I wish to present. Trains A and D are the ones between which my comparisons were made, while the other trains, at intermediate speeds, serve as a check upon the more important ones at extreme speeds.

Train	No. Cars	Speed	No. Stops	Mileage		Coal Used—Tons		
				Train	Car	Total	Per Day	Per Car
A	6.76	31.33	18	34480	233802	1151.8	6.36	170.38
B	6.24	35.70	8	34480	215110	1111.4	6.14	176.11
C	2.95	45.40	7	34480	101525	1091.7	6.03	369.83
D	3.88	48.00	7	34100	132240	1274.1	7.12	328.35

The above figures, as already explained, cover only the items of fuel, wages, and engine and roundhouse service, and the cost of engine and roundhouse service was assumed to be the same for the two engines.

The conclusions are simply that, so far as the items considered are concerned, there is a decided increase in the cost of hauling cars as the speed is increased.

A comparison of the figures, showing coal used per day in the table, certainly substantiates Mr. Delano's suggestion that the coal consumption per car or ton of train is proportionate to the speed, as, for train A we have 170.4 tons of coal burned, per car, in six months, while for train B we have 328.4 tons, an increase of over 92 per cent of coal burned for an increase of 53 per cent in speed. This is due, not only to the increased resistance at the higher speed, but also to the fact that the capacity of the engine is less at high speeds, and that with large or small trains, the engine has to propel itself as well as pull the train.

If a material increase is made in the speed of a heavy train, the question of locomotive capacity is almost sure to come up, and, as Mr. Delano has pointed—the service is likely to call for a heavier engine, at an increased cost, and very likely entailing additional expenses in the way of improvements in track and bridges.

Mr. J. F. Deems (C., B. & Q. R. R.): I have nothing to say in detail of the paper, but there is one thought that occurs to me. In the October number of the *North American Review* I read an article by Ian McLaren, pertaining to the vital energy and force of the American people. I can not give it in detail, neither can I give the exact title, but he had a great deal to say in regard to the push and vim and snap of the American people, and he went on to say, in one instance, that when one of these high-pressure, high-tension Yankees came into his study and visited with him, for an hour or two, it was like an electric shock; he felt stimulated and vitalized for weeks. I suspicioned, at the time, that Professor Goss had called on him. (Laughter.)

But, aside from that, the thought that occurred to me, and which connected that paper with this, was this idea, Is it not possible that with these high speed trains we are keying up every one on the line to a much greater extent than we know, and to a much greater extent than it is possible for us to ascertain definitely, and do not we get in return, due to that keying up of everybody, almost as much as these trains cost us?

Now every one here knows that with the increased speed of trains there has been a corresponding decrease in the number of wrecks we have had. Whether it is due to the increase of speed or not, I am not prepared to say, but I am inclined to think it is. We know, at least, that we do not have near as many wrecks as we used to. Now

it is not due to the increased speed itself, but due to the fact that the men, realizing the danger, and realizing the importance of these trains, are more careful, and they are in better mettle and they do better work than they used to when running fifteen to twenty miles an hour, and that is the thought that occurs to me, whether there is not an element of saving grace in that line that perhaps compensates fully for what we lose in running these high speed trains.

President Hetzler: Professor Breckenridge, I notice you are over there. We would like to hear from you on the subject.

Prof. L. P. Breckenridge (University of Illinois): I really did not intend to say a word. I have been interested in the discussion and was interested in the paper, and came in because I wanted to gain some information. I certainly, Mr. President, have not any data to give, and do not know anything about this matter. I will ask you to excuse me on the basis that I have not had any experience in the operation of trains at high speed. I certainly can not add anything of value to the information that has been given at this meeting. I am much obliged to you for calling on me.

Professor Goss: Mr. Delano makes two statements which, at first sight would seem to be somewhat at variance, but which, rightly interpreted, are entirely consistent.

The first statement is that to operate a train at sixty miles per hour, as against thirty miles per hour, increases the fuel consumption by something like 62½ per cent. The second is to the effect that engines of more than twice the power do not now handle half as long trains as those which formerly handled ten or twelve cars successfully, and which are now relegated to branch lines.

The first statement is based on work done in covering a given distance. The second statement upon work done in a given time. The first statement indicates that when speed is increased from thirty miles to sixty miles, it will require 62½ per cent more power to carry the train each mile, but as, at the highest speed, the work of overcoming the resistance of the train is accomplished in half the time required at the lower speed, the rate at which power is developed becomes proportionately greater.

Power measurements are usually based on time. Taking the data presented by Mr. Delano, in connection with the first statement to which I have called attention, it can be shown that an increase of speed from thirty to sixty miles should be expected to increase the

rate of fuel consumption $2\frac{1}{4}$ times, a result which is quite in accord with the observed fact as indicated by the second statement.

Thus :

For thirty miles,

$$\text{Train resistance} = 3 + \frac{1}{6}V = 3 + 5 = 8$$

For sixty miles,

$$\text{Train resistance} = 3 + \frac{1}{6}V = 3 + 10 = 13$$

That is, the force necessary to maintain the motion of the train in the two cases is as

8 to 13

But power is the product of force multiplied by space passed over. Hence, in the present case, the power required for a speed of thirty miles, will be to the power required for a speed of sixty miles, as

$$8 \times 30 : 13 \times 60 = 8 : 26$$

which gives a percentage increase of power as compared with that required at the lower speed of

$$\frac{26-8}{8} 100 = 225\%$$

This, as already stated, is in substantial agreement with Mr. Delano's second statement.

Mr. Henderson : What Professor Goss has just said has made me think that possibly I was not entirely clear when I spoke of 140 per cent increase in the rate of fuel consumption ; I did not mean in time, but I meant per ton mile. I thought perhaps Professor Goss was speaking of the time unit, and I was speaking of the distance, and the 140 per cent increase, I should have said, was that much increase per mile, or per ton mile.

Mr. H. D. Judson (C., B. & Q. R. R.) : I did not see Mr. Delano's paper until I came into the room, and had no thought of making any remarks. I remember hearing the genial Dr. Depew say once, that clubs and associations always seemed to want to be instructed by some one who knew less of the subject than they. It is on this theory that I account for your calling on an operating man to tell a technical club what it costs to run trains at a high rate of speed. It is a subject, however, that interests the operating department very much.

Mr. Deems has suggested that we, perhaps, gain in vital force. It is a question with me whether we do not lose ; whether by reason of excessive strains we do not become unduly nervous.

Mr. Delano has given us some facts and figures, and there is just one point that I would like to call attention to, and that is the fact

that the excessive speed at which we are required to run, obliges us to haul lesser tonnage. We frequently run our stock trains, for instance, at such a rate of speed that we cannot haul anywhere near the tonnage that our locomotives are capable of hauling.

I was very much interested in every point that has been brought out. The figures are something that I know nothing about; I do not question them, but the question that occurs to the operating department is, conceding every point that he has made, the question is the one propounded by a great and bad man, "What are you going to do about it?" There is no question but what it costs vastly more. Mr. Delano has not answered the question—and I do not suppose he expects to—as to what it costs to run trains at a very high rate of speed, but he has proven what we all know, that it costs vastly more to run at high speed than it does at lower speed.

The figures which Mr. Clark has prepared, and which are on the wall, are figures which should interest not only every mechanical and operating man, but every stockholder of a railroad company, and I hope they will have the effect of calling the attention of those who own our railways to the waste of revenue that is being caused by excessive speed, and I hope that railroads will some time get together on the question of a maximum speed. We will assume, perhaps, that we cannot reduce the speed of passenger trains, but why should we run every freight train at such an excessive rate of speed? If there is a traffic official here, he will bear me out in the statement that time is of the essence of every transportation contract. In the matter of freight transportation we have come to a point now where a man says, "If you cannot get my goods to me by the next morning, I will try some other road," and it is true not only live stock and merchandise, but every car of junk has to be handled in the same way, and it seems to me that it has reached a point that is positively ridiculous, or would be if it were not so serious.

There is, perhaps, no one thing railways can do which will bring larger returns than to reduce the speed of trains. It is a question, however, which, because of excessive competition, no one road can settle for itself. It is to be hoped they will sometime see it to their interest to reach an understanding which will enable them to run slower and haul large trains. In the meantime, it would be interesting to know just what excessive speed is costing us, and I hope it will be determined.

Mr. E. E. Russell Tratman (*Engineering News*): What struck me most in regard to Mr. Delano's paper was the title. He asks what the cost is. Now, what officer of any road can tell the exact cost of operation of any particular train on his road? We can get averages galore, but when we come to actual and definite figures for any particular service, we find that they are not available. We can turn to the reports of the Interstate Commerce Commission and find the average weight of trains, the number of cars per train, number of passengers and tons per car, etc. But what do these mean when we want to figure on cost of operation? These averages include the busy lines, the little branches, and the lines of freight traffic; also, the through freights and the way freights, the big trains and the little trains. Similar figures of individual roads are given in the annual reports of these roads. For instance, take the average tons per freight train. I think the highest on record is about 450 tons on the Chesapeake & Ohio Railway. Now, many roads are running freight trains of 1,000 to 3,000 tons, but these do not show in the averages, nor is there any knowing whether the officers of the roads knew how the cost of their operation in detail compares with that of the ordinary freight trains.

Take cost of the service, and you can get a lot of figures, all averages, but they are of little use in regard to the important and interesting question propounded by Mr. Delano. Perhaps they may serve as a basis for working out more exact figures. Here, for instance, are a few examples of these averages, representing, as a rule, engines and trains of every class, and in every kind of service. Can these and other figures be secured for, say fast "limited" trains and ordinary passenger trains; for fast freights and way freights? If so they might lead to great changes, improvements and economies n service.

CHICAGO & NORTHWESTERN RAILWAY.

Repairs and supplies for engines and tenders, per mile run	4.66	cts
Engineer, fireman, wipers, etc., per mile run........................	7.29	"
Oil, waste and tallow, per mile run..........	0.23	"
Fuel, per mile run....	6.35	"
Total cost per mile run by engines.........	18.53	"
Run per ton of coal..........	22.84	miles
Run per pint of oil	15.40	"
Run per pound of waste	182.93	"
Cars per passenger train.	4.75	cars
Cars per freight train (loaded)...................	16.87	"
" " (total).....................	22.92	"

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.

Repairs of locomotives, per mile run	3.25	cts
Engineer, fireman and wipers, per mile run	0.87	"
Oil, tallow and waste, per mile run	0.16	"
Fuel, per mile run	5.96	"
Run per ton of coal	28.78	miles
Cars per passenger train	4.95	cars
Cars per freight train	20.18	"

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

Repair of locomotives, per revenue train-mile	5.60	cts
Repair of cars, " " " "	7.97	"
Station service, " " " "	11.25	"
Train service, " " " "	7.23	"
Locomotive service, " " " "	8.60	"
Train and station supplies, " " "	2.01	"
Fuel, " " " "	9.44	"
Oil and waste. " " " "	0.47	"
All other expenses, " " " "	44.66	"
Total operating expenses, " " "	97.23	"

There seem to be no definite figures outside of these averages. Mr. Delano refers to a friend of his who gave the cost of operating a fast train as $2.00 per train-mile. Perhaps Mr. Delano can get from that gentleman some particulars as to what he based his figures on, and find out if he made any investigation of the matter, because, as I say, we seem to be working in the dark in this respect. We ought to be able to figure out the cost of transportation for a particular service, somewhat as manufacturers figure out the cost of manufacture or production of certain articles. It would be a good thing for the railways if they could take some particular trains in some particular service on one particular line or division, and study out the cost of operation for a few months or a year. If anybody would do that, we might have some definite figures upon which to base further investi gations, but at the present time we have really nothing to go upon except these averages, and they really have no bearing upon the matter under discussion.

Mr. A. E. Manchester (C., M. & St. P. R. R.) : I came in so late that I do not know what has been said heretofore, and I do not believe I can say anything that will add to the value of the paper. It is a subject that we have not much data on, and I hope that some of those who have been discussing the paper are better prepared in

that respect than I am, and when I get a chance to read what has been said here this afternoon, that I may get some good pointers.

The subject of fast trains involves a great many conditions on a railroad, and even with the figures we have, while we know that it costs more to run a train fast than at a reasonable rate of speed, yet we have numerous figures that show that some of our freight trains, run at a reasonably high rate of speed, are being operated for less money than the slower trains. Now, while I feel sure that that does not mean that we can run our engines thirty miles an hour, and pull a train over a road, and do it as economically for fuel as we could at twenty miles an hour, to me it means this, that the fast train is given the right of way; it does not sidetrack, it does not switch; while it is hauling less tonnage it has a practically clear track, and it makes the run in a short time, and on these accounts it really shows up for fuel less per 100 tons haul per mile than some of the heavier trains that have to do more way work and get no credit for it.

Mr. W. H. Marshall (L. S. & M. S. Ry.): I realize fully the advantage of figures on the cost of locomotive expenses for handling fast passenger trains. I feel, however, that if we do obtain definite information on this point it still leaves almost every case as a special one to be decided by itself, and the cost of operating, from a mechanical department standpoint alone, is possibly a very small factor in the total problem.

The points that Mr. Delano has brought out in his paper we will all concede. However, it may be quite a different problem to operate just a few fast trains or to operate the entire passenger service of a road upon a comparatively fast schedule. If we are to operate a few fast trains only, it may be well to purchase a few engines of sufficient power to do the work under the conditions that exist upon the railroad at the time the new schedule goes into effect. If, on the other hand, a considerable number of fast trains are to be considered, purchasing of large locomotives may be one solution of the problem, but it is not always the only one, nor necessarily the best one, and I think the manner in which these problems are approached means a great deal to a railroad company.

We all know that trains that are scheduled at thirty-five miles per hour can make speeds very much higher than is necessary to maintain that schedule; in fact, they may be able to travel as fast as is necessary for a fifty mile per hour train, providing the latter can go along

without any detentions, but we always have to provide a surplus power for these detentions. Now, evidently, the best way in which to provide for the fast service, is to eliminate all causes for detentions. By these detentions I do not simply mean the delay at stations, but the changing of many things along the line of the road that prevent fast speed. In some places it may be the use of track tanks, the location of signals, the installation of interlocking plants; in other places the elimination of sharp curves or a bad grade, more and longer sidings so that freight trains can get out of the way. These and many other such items have their effect upon high speeds, and where most of these chances for delay are eliminated, the engines do not have to be as large as if no changes of this character are made.

The Lake Shore has a great many comparatively heavy trains; they are not so very fast, as fast trains go, few averaging much more than forty miles per hour. They have, as you know, until recently been operated by comparatively small engines. When I went there it was a matter of astonishment to me to know that the engines could do such work, and looking over the situation I have come to the conclusion that it is very largely because the trains require little acceleration after they are once started; it is largely a question of keeping them going for many miles at a stretch. Undoubtedly, the engines were too small for the work, but when an 18 x 24 ten-wheel passenger engine with a 68-inch driver and 190 pounds steam can handle an eleven, twelve and even a thirteen car train at a schedule of forty miles per hour, including all stops, it is very evident that there was not very much demanded of the engine in accelerating the train after it was under way. I am of the opinion, that in fast passenger service there is much more power consumed in the frequent accelerations of the trains than is generally assumed.

Now, if in solving its own problem of fast passenger service, a railroad company would endeavor to correct those physical features of its roadway which have a tendency to prevent the attainment of high speeds, some of which I have already enumerated, it will find that every dollar spent in that direction is reducing the expenses of the operation of other trains, both freight and passenger. Work in that direction will certainly pay, and when carried out intelligently we may still need large passenger engines, but they will not need to be as large as if comparatively little attention is paid to these physical features. As Mr. Judson says: "What are we going to

do about it?" The fast trains are here, why not attack the problem in that direction which is going to give the greatest benefit to entire train service? Then for the expenditure we will have, as a partial offset, the reduced cost of operation of other passenger and freight trains.

Mr. G. W. Rhodes (B. & M. R. R. R.): I have been very much interested in this paper, and very much interested in the discussion that has taken place about it. I was wondering when I read the paper over, how Mr. Delano would come out. In his concluding remarks he says: "The point I wish to enforce is, that speed costs heavily; just how much I am not prepared to say."

I think it is a little remarkable that at a meeting of the Western Railway Club there is not one present able to answer Mr. Delano.

I will not go into all the different points that Mr. Delano has brought up, but it seems to me there is a great deal in them. The way Mr. Henderson enlarged on the questions is interesting, but what I would like to call the Club's attention to, is the way in which we have got after some other problems in railroad work, and to see whether, not having the information at the Railway Club, we cannot dig it up somewhere else, and if we cannot dig it up anywhere, then whether we cannot devise some means by which we will get the information anyway. When I think of the way we changed the method of couplings between cars, from the link and pin to the vertical plane coupler, and of all the investigations that were made in that line, and the care that was taken before the railroads committed themselves to that particular form of coupler, I wonder whether, possibly, some of the roads not attending here this afternoon may not have learned something of some kind about speeds.

I recollect on one road, before the vertical plane coupler was fairly adopted, that a special train was provided, with a good load, and that it was taken with some of the principal officers of the road from Chicago to Denver, a solid train, for the sole purpose of determining whether this change in coupling between cars was going to be a success or not. I was on that train; one or two special cars were put back of it—I forget the number of cars, whether it was thirty-five or forty—and the coupling and switching at the various points was done as the train went along, to determine the results of handling a train of that kind at reasonably high speed. On the line that I am connected with, where we run pretty fast trains for our

stock trains, and before we had the vertical plane coupler, we went to the trouble of getting solid iron wedges and blocking them between each link and pin coupler to do away with the slack in the train. Other roads, no doubt, made similar investigations ; the result is that we went into the coupler change, not blindly, but knowing what the results were going to be.

Then again, take the question of brakes. See how carefully that subject was gone into, and what moneys were expended in ascertaining what was the best kind of brake to use ; but as soon as the car builders mapped out how the work was to be done, tests were not confined to one road ; one of the brake companies organized a train and went all over the country, showing how these brakes could be operated, and successfully operated. Other railways, when they wanted to find out something about brakes, took up the tests and made them ; brake tests, some five or six years ago, were quite a common thing.

These tests were made sometimes, if not with the opposition, at any rate not always with the cordial support of the manufacturers. If they could find purchasers they would naturally rather sell their goods without meeting conditions, and I sometimes think that some railroad officers would rather operate their trains without knowing just what they cost.

My friend, Mr. Judson, remarks, "What are you going to do about it?" I think that one of the things to do about it is to let every operating officer, when he increases the speed of his freight trains from twenty miles an hour, say to forty miles an hour, be able to answer just what it is going to cost him in dollars and cents in making that increase.

In the last annual report of the Northern Pacific road, special attention is called to the great cost to railroads in operating freight trains at speeds which are not warranted. Now, why do we say it costs so much to operate trains at speeds which are not warranted? We have got no actual facts about it. We can all theorize as we have done this afternoon, but we can not show any definite test that has been made. Mr. Tratman brings that out ; there are not any accurate figures that you can show.

My experience has been, on some lines, that if you get one fast train on, it brings up everything else fast. The fact of the matter is, if you get a fast freight train on a road, with signals as ordinarily

provided, and then attempt to run some slow freights, you will find you can operate more successfully, and with fewer accidents, if you disregard cost entirely and keep everything moving fast. I know that in some investigations we made on the C., B. & Q. we found this was actually the practice ; when we wanted to see why our coal consumption was increasing, we found everything was running fast on account of a few fast trains, but how much more it was costing us in supplies the operating officials had no data.

The late Henry B. Stone, before he gave up railroad work, had in view getting some actual data on the very results that we are looking into this afternoon, and he talked with me about making some actual tests with a given train at different rates of speed : at twenty miles, thirty miles, forty to fifty miles an hour, so we would know what it cost in the operation at these different speeds.

The data that Mr. Clark has given on the table there is very interesting, but it has not a given tonnage going at different rates of speed. As I understand it, those are different classes of passenger trains ; some of them stop at many stations and others do not, and therefore it is not a comparison. We know in a general way that it costs more to run high speed than it does to run low speed, but how much we do not know, and I would think that it would pay the railroad companies well to do what Mr. Stone proposed to do; to take a given tonnage and run that over the road, keeping actual data of what the results are; and then we would know whether it is going to pay us to run dead freight at speeds at the cost of handling stock or handling fast meat trains.

But, perhaps, before it is necessary or wise for the railroads to take that up, it would be a good plan to consider what has been done already ; some of this work may have already been done, and I would propose, before the meeting is closed, to offer a resolution which I will read later, that this subject be referred to other organizations; let them investigate the same question and ascertain what has been done in the work, and then I hope that, later, some of the railroads will undertake it, as Mr. Luttrell suggests. I do not know whether the Burlington road will undertake to do it for the benefit of the railroads in general, but there will be nothing in the world to prevent any of the roads from making those investigations for their own information, which need not be given to the public. It is an important question, and we ought to know what the difference in expense is to haul

a given tonnage at the rate of twenty miles an hour and at the rate of forty miles an hour. I will offer a resolution to the above effect later.*

Mr. Daniel McBain (Michigan Central R. R.): I do not know that I can add anything to what has been said. I think Mr. Miller has covered the ground fully, and about the same as I would put it myself. As to the reason that we are now hauling freight at the same cost per ton as we did when the speed was fifteen miles per hour, I believe it is due to the fact that the speed of the train despatchers and all others has been increased correspondingly, and this, coupled with the more intelligent manipulation of the locomotive, has made it possible for the cost per mile not to become greater.

Prof. Goss: The suggestion has several times been made that when a given engine is changed from a slow schedule to a fast schedule it works at a higher rate of power. Can this be true? The fact seems to be that all engines in through service, which are operated at speeds above twenty miles an hour, are worked to their full capacity. Engines thus operated consume all the steam that the boilers can be made to deliver. When, therefore, an engine which has been operated at a speed of twenty miles is put at a schedule requiring forty miles, cars are dropped off the train, but the engine is not worked any harder. Except by picked coal, or other incidental means, it cannot be made to work harder for it was at its full capacity at the lower speed.

Again, we have been trying to account for the increased fuel consumption at high speeds, on the assumption that the engines were less efficient at high speed, an assumption the truth of which I am inclined to question. Locomotives operated at slow speeds are not efficient, but when the speed has been allowed to rise to twenty miles an hour, the wasteful limit is passed, and for all high speeds conditions which are nearly those for maximum efficiency prevail. Doubling the schedule speed, therefore, does not decrease the efficiency of the locomotive.

A Member: On the basis of coal burned per horse power per mile?

Professor Goss: Yes, or on the basis of fuel per horse power per hour.

I have raised the question concerning the power developed by our very large engines at high speed, and would suggest that reliable data along this line cannot fail to interest the Club. I do not think there is any considerable volume of such data in existence. The indicator

would seem to present the greatest promise, and yet, as has been shown before this Club, the conditions of locomotive service involving high speeds of revolution, and long indicator pipes, are not favorable to satisfactory results. Power measurements, under such conditions, become nearly estimated, and are always likely to be in excess of that which is actually developed.

A statement has recently been made before an eastern railway club, crediting an engine with having developed a horse power for each square foot of heating surface in the boiler. This is a limit which, in my opinion, has not yet been sustained in locomotive service. I do not think it is possible to hold any locomotive up to such a power for any considerable length of time. The maximum probably lies between the limits of one and one-half and two feet of heating surface per indicated horse power. Such an allowance indicates that some of our larger simple locomotives may develop from 1,500 to 2,200 indicated horse-power, and that compounds may do something better than this. Such powers must, I think, be accepted as maximum in present practice

In this connection, I would suggest that, since it is likely that all simple locomotives give substantially the same cylinder efficiency, it should be possible to base an estimate of power upon water consumption. Under good conditions of practice, the water consumption should fall between twenty-seven and twenty-nine pounds per horse power per hour. Accepting twenty-eight pounds as an average, we may write for simple engines,

$$\text{Horse power developed in cylinders} = \frac{\text{Pounds of water evaporated per hour}}{28}$$

A modification of this rule is,

$$\text{Horse power developed in cylinders} = \frac{\text{Gals. of water evaporated per hour}}{3.4}$$

or, the rule may be stated as follows: Allow 30 horse-power for each 100 gallons of water evaporated per hour.

The fact should be emphasized that these rules assume all engines to have the same cylinder efficiency, and by them an engine of superior efficiency would show less power than it should be credited with, but variations either way are not likely to be in error by as much as 10 per cent.

In a similar manner the coal consumption may be made the basis

of an estimate of power developed, though as such an estimate is affected by the boiler efficiency, it is less satisfactory than those based on water. The following rule, however, should give an approximate measure, though in danger of being in error by as much as 20 per cent in individual cases ; it applies only to simple engines. It is—The horse power developed in cylinders equals pounds of coal consumed per hour divided by 5 or 6 ; by 5 if coal is of superior quality, and by 6 if of inferior quality.

I wish we might have presented, as a part of this discussion, some record showing length of runs, time on road, total fuel consumption and total water consumption of some of the larger modern engines.

Mr. Delano : Mr. Chairman and gentlemen, I have talked already more than enough on the subject, but I do want to thank the members for the interest they have taken and for the information they have brought to the meeting.

There were one or two questions asked which it would seem ought to be answered, in part anyway. Mr. Tratman asked in regard to the figure mentioned in the paper, $2.00 per train mile, as being the estimated cost of high speed special service. I do not know that there is any objection to stating that that figure was given by a general superintendent of the New York Central road, in testimony, I think, before a congressional committee, or possibly some New York legislative committee, and, I assume, referred to the Empire State Express, which is a fast train. I state in the papers, at a guess, that the figure is not very far from right. The way I got at that was this : The average cost of train service for all the roads of the United States, lumping together passenger and freight, is given in the Interstate Commerce report as 97 cents per train mile ; adding to that, as they do, fixed charges, in which they include taxes and interest on mortgage, but not dividends, brings that cost for all the railroads in the United States to $1.47.

But assuming that figure of $1.47 as a fair figure for an average, we can then estimate how much the cost of fast service is, above or below. The suggestion has been made by a number of men, here and elsewhere, that up to a certain point it costs less to run a train at high speed than at low speed ; or, in other words, that the resistance curve would show a *hump* in it, the cost would be decreasing down to a certain figure, and then increasing. I doubt if there is anything of that kind. I think that is a fiction which is produced by special condi-

tions. For instance, to talk about hauling a passenger train at fifteen miles an hour would be more or less absurd, because with any standard engine we could haul at that speed a great many more cars than you would want to put on a passenger train.

In regard to freight service, it has been said here that ten or fifteen years ago it cost about as much per train mile as it does now, and still trains took twice as long to go over a division. That is all very true, but a large part of the time spent in going over a division was, as has been hinted, wasted on sidetracks.

The fact must always be borne in mind, I think, that in order to successfully handle a large number of trains, it is absolutely necessary to keep the average speed reasonably near the same. That is, you cannot operate freight trains at ten miles an hour, and passenger trains at thirty or forty miles an hour, and mail trains at sixty miles an hour, and keep them successfully moving over the same tracks. There is a degree of interference and a necessity for sidetracking which operates seriously against such a schedule.

Mr. Deems spoke of the gain by fast service in keying up the entire service. I was recently at a meeting where the subject of reducing grades was up for discussion, and one of the arguments urged in favor of reducing grade was, that there would be a diminution in the number of accidents over a certain piece of track where the grades were now severe. "But," said one of those present, "we do not have many accidents on that piece of track; everybody is a great deal more careful." On mountainous or hilly roads everybody is a great deal more careful, but I hardly think that that fact should be seriously used as an argument for not making improvements in grades, nor do I think it ought to be made seriously as an argument for maintaining excessively high speed service if there are strong arguments against it. Gentlemen, I thank you very much.

Mr. G. W. Rhodes: In accordance with the suggestion I made a short time ago, I would now offer the following resolution:

Resolved, That this paper, with a copy of the discussion thereon, be sent to the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Railway Master Mechanics' Association, and the Western Society of Engineers, calling the attention of these associations to the wide scope of the subject from a practical and engineering standpoint, and ask them to have

the matter brought up for consideration and discussion in as thorough and complete a way as they may think fit.

The foregoing motion was seconded and carried.

RECESS.

BOILER FEED WATERS

President Hetzler: Our subject for topical discussion is: "Boiler Feed Waters; Different Treatments, Why They Fail; Results Obtained; Action of Known Chemicals, etc." By W. H. Edgar, president of Dearborn Drug and Chemical Works, Chicago.

Mr. W. H. Edgar: Mr. Chairman, and members of the Western Railway Club, I have been requested to read a paper on the subject of Boiler Feed Water Treatment, and I thought probably I could do better by giving more of an informal talk.

Boiler feed water, the different treatments, why they fail — I believe they have all failed, so I say, "why they fail;"— the results obtained; action of known chemicals.

On the action of known chemicals, I will confine myself to chemicals or drugs, or such antidotal reagents as we are all familiar with, or that can be purchased at the wholesale druggists or on the open market. I would not recognize anything under proprietary name, or use the name of a patent medicine, or a secret.

The water used in the boilers we take from the rivers, creeks, ponds, surface wells, artesian wells, and, by analysis of each water obtainable in that locality, we select the best or the purest for our boiler feed. Artesian well waters cause foaming; they give us a great deal of trouble with the joints and the connections, they eat the valve seats, the packing, and go through the seams, cause a general deleterious action, and eat away the threads in the connection, all of which you are familiar with in practice.

The surface waters form scale, that is to say, form a heavier more dense scale or incrustation than the average artesian or surface well— that is, 300 feet; I generally term the 300-foot well supply, surface wells. This deposit or incrustation is composed principally of the carbonate of lime, carbonate of magnesia and sulphate of lime, the silicate, which is sand, and which exists in the water in solution to the extent of one or two grains to the gallon, in some cases as silica dioxide; we have every reason to believe it enters into the scale formation, and possibly we can get a silicate of magnesia, or silicate of lime.

In the early days, back in the days when we first used high pressure, in Scotland they introduced potatoes and got some results which were due to the tannin in the potato peel and the pulp boiling into starch, and from that to sugar, giving us a saccharate, and the reactions could possibly be written as tannates and saccharates of lime. Later on, sugar was recommended by the different German chemists, which has been successful in some cases. Then we have fluoride of sodium, phosphate of sodium, carbonate of sodium ; all have been recommended as a boiler compound, or as a possible antidotal reagent, and I will say the reason sodium salts have failed is as follows :

We will first take up the subject of using carbonate of soda. The carbonate was recommended. As we know in chemistry, it will convert a certain amount of sulphate of lime into carbonate of lime, and any excess of the carbonate of soda, technically speaking, ought to keep the normal carbonate of lime in solution, or in a sludge, as a bi-carbonate, or partially so, or enough to keep it from adhering.

A short time ago, possibly two or three years, fluoride of soda was recommended, because the calcium fluoride is a flocculent precipitate, you might say, a light flocky precipitate, which would not adhere and could be readily washed out as such. We could not use the hydrofluoric acid because we would get an action direct on the metal, as an acid would attack the metal instead of the carbonate of lime, but, using the fluoride, we get an exchange of bases and acid radicals ; they had to have an exchangeable base and the base had to be a soluble one, and soda was the only possible base to be used. They did not figure on what would become of the soda base ; after we got our exchange the soda would naturally go to the carbonate and to the sulphate, and the lime would go to the fluoride, the soda salts being left in solution.

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Third line from last, should read one pound instead of three pounds.

same object in view. We have had caustic soda recommended; but there is no action between the caustic soda except when you use an excess; the carbonate of lime is then soluble. But they do not state what becomes of the soda. That is left in solution and the water in the boiler becomes saturated and this soda attacks the joints, the iron and boiler connections—which you readily understand from your experience with artesian well waters; all sodium waters saponify, that is, cause the water to foam, and if any organic matter works its way into the boiler, you readily get a saponification and your water foams and carries over; and even without the presence of some organic matter, your water becomes so dense and is of such a soft, sodium nature that it suds. We could not readily say it saponifies, but it forms more of a suds, and when your water is sudsing or foaming, it is constantly throwing water in little minute particles up into the steam space and as the little sheets or bubbles break, they are carried mechanically with the steam, you might say blown over; your steam is moist and it is this moisture that contains the soda salts. The soda is not volatile but is carried over mechanically and it is this soda that causes trouble in the cylinders with the cylinder oil. The more moisture you have in your steam, the more animal oil you have to use in compounding your cylinder oils.

If you had absolutely dry steam, you would have no trouble in getting the cylinder stock; that is, pure mineral oil with a sufficient viscosity and high enough flash and fire test to give perfect lubrication; but moisture washes straight mineral oil off from the surface and destroys its viscous, adhering, film-forming, clinging properties.

From a lubricating standpoint, we have to compound with animal oils to meet the moist condition, or to take care of cylinder lubrication in the presence of moisture, and that really should hold good at all times; there never should be a bit of animal oil used except to take care of the moisture. The more sodium you have in your water, the more foaming you will have in generating your steam and delivering the same to your cylinders; the more foaming, the more moisture in the steam, consequently the more compounding needed in the oil. In turn, this moisture contains the sodium which saponifies the oil. That calls for more oil in the cylinder. You destroy your lubrication when you introduce soda into the boiler.

I believe I have now covered that part of the subject which some two or three here wished to have explained more than any other part

of the work and, I believe, if you will follow this up, you will find it true. I do not think it is possible to build up on sodium whatsoever, in putting together a preparation to counteract the adhering incrusting of the lime and magnesia on the sheets and flues of the boiler. You are simply exchanging bases, using a salt with the object of conveying, or for the purpose, I might say, of getting the results from an acid radical; using a sodium base, you leave the exchange in solution and it is this sodium (carbonate and sulphate) that causes such deleterious action and makes the cure worse than the disease.

Some years ago a man in New York, whose name, I believe, was Rogers, brought out a tannate of soda and introduced it on the market as a boiler compound. The reason that tannate of soda failed was due to the fact that he used nothing but pure straight tannate of soda, and, of course, in the reaction he got tannate of lime, and carbonate and sulphate of soda in exchange; principally, carbonate of soda. Now, I believe, if he had taken a mixture of about 8 or 10 per cent of tannate of soda and about 60 per cent of tannin, not the tannic acid but the tannin extract, containing the saccharine and general inert matter of the extract, about 30 per cent of a mixture of cane and grape sugar, with a certain amount of soluble starch, he would have converted the carbonates of lime and magnesia into tannates, and the sugars would have converted the sulphate of lime (gypsum) into a saccharate of lime or saccharated calcium oxide. It also exists as a straight saccharate of calcium, losing one molecule of water, in a boiling solution. That is, allow me to state, that all lime salts are soluble in a boiling solution of sugar.

This saccharate, we might go so far as to say, breaks up into a tartrate, from that to an oxalate, from an oxalate to a carbonate and, in the presence of our tannin matter, we would get a complex mixture of carbonate, tannate and some oxalate, and up to the saccharate. Now in exchange we have got a certain percentage of tannate of soda. The soda gives way to the calcium, but it goes to the free tannin, which is practically available tannic acid.

We have not got an extracted tannic acid, but, instead, we have an available tannic acid in extract form, which gives our reactions. According to these theories, we have a complex reaction and a complex mixture as a result in organic chemistry. We have in steam boilers an existing condition that we do not obtain in the laboratory. We have there, beside the high temperature and the high boiling point,

a galvanic battery, and, especially in locomotive work, where we have about one-half the steam capacity of a stationary boiler. We have our iron plates and tubes, our brass connections (zinc and copper alloys) which are subjected to the different degrees of heat; they are expanding and contracting, and, wherever a metal is subjected a high temperature and when we are delivering heat units to the boiler sheet, transmitting same to the water, we produce a magnetic, or, possibly, galvanic battery. Our battery does not exert its influence nor do we get the galvanic current or action between our poles, positive and negative, due to the fact that we have not present an electrolite, or a conductor. The foreign substance in the makeup of the plate will not act as an electrolite, the water being a lime water, its solvent properties are satisfied; it does not act as a conductor, although we know that the galvanic battery work calls for an acid solution. Yet in boiler practice, wherever we have a sodium water, or a water too pure, we invariably get the pitting, grooving and general eating away of the iron plate, or some three or four plates, or different parts, and I have personally changed the location of the positive pole. Iron is always positive to copper negative; also iron molecules are positive to iron molecules negative; a boiler, which is pitting from too pure water, or the pitting being much more rapid in certain cases, due to the water containing an excess of sodium salts, place a copper plate or some copper wire in near this location of pitting, and you will change the pole; you can change the pitting over to another sheet. Many a boiler plate and many tubes have been condemned on account of the material, but I do not believe it is the material, from what I have seen in practice. I believe it to be a condition in the water, and you often find cases of pitting in boilers, which they term electrolysis, which, truly speaking, should be called galvanic action; the water is too pure, and not only too pure but also contains an excess of sodium salt over the amount of lime present, and acts as the electrolite.

To prove this, we will mention marine service: They have for years hung zinc in their boilers; they never have any incrustation; they never have any scale forming or any lime deposit; the only trouble they have in their boilers is pitting; a constant eating away of the boiler plate, seams, the skin of the iron, the finish being actually eaten into little raw, deeply eaten holes, and, in many cases, a little scab forms over this hole; you tap it with a hammer and you find there a baked yellow mud, underneath you will find a moist red mud. By

analysis, we find the red composition to be ferric-hydrate, and we find this substance that forms the scab to be iron oxide.

In a boiler that is pitting, we find some sludge. We take this sludge and wash it under the hydrant in our hands and finally wash out some grit, which has the physical appearance of emery. If you will examine this, you will find it to be the black magnetic oxide of iron, formed from the ferric-hydrate by boiling. In marine practice they stop this pitting by hanging zinc in the boilers ; zinc is a more positive metal than iron and is destroyed in place of the iron. That being the case, I believe our theory to be correct, relative to attributing this pitting to galvanic action.

In marine service they simply furnish a substitute. I believe, if you satisfy the water you will stop your battery, and thereby stop all pitting ; you will also satisfy the solvent properties. If the water is not satisfied with lime of one or another substance, it will take up the first base with which it comes in contact.

In using the tannin it is well to use catechu, sumach and oak extracts in extracted form. In using the sugar it is well to use cane sugar, grape sugar and then some bark starch, such as slippery elm, birch or beech wood, soluble potato starch, etc. If you use raw potatoes, there will be a great amount of the pulp which would not readily convert into a starch. In using starches with your sugars, it is all convertible and soluble, and you would not get the slush in your boilers which you would receive from the use of potatoes or unconverted starch.

It is wrong to call the use of tannins and sugars, vegetable treatment. That might cover a great many different substances, but it is in the sugar and tannin treatment, reaching the sulphates with saccharate mixtures, and the carbonates with tannin, and, having an excess of your available tannic acid over the percentage of tannate soda, that I believe you will get the result looked for. It matters not where you buy these substances ; you can buy them at all the wholesale drug houses. I think if you are ever going to handle the subject successfully in a steam boiler, you will have to use the tannins and sugars. You have your replacable soda in the soda tannate. This soda goes to your available tannin, not in exchange, but by displacement ; I believe we all agree in saying that this is possible. You also have an excess of organic matter present, you have a substance upon which the sodium salts will spend their force instead of the metal, and they

will prevent all such action on the iron joints and, I believe, accomplish as high as 95 to 100 per cent of the work in preserving the iron and giving a dry steam.

You have to analyze the water to know how much sulphate is present and how much carbonate may be present and, in railroad practice, where you have a great many different tanks or tubs along the division, you will have to prepare your preparation specially for each, and introduce so many ounces or pounds to each one, two or three thousand gallons of water put in the tub, treating the water beforehand, so that as the locomotive comes along, and as the engineer takes water at each station, you will have your sugar and tannin, your antidotal reagents, proportioned to suit the water, and the mixture of your compounds so introduced to meet the requirements in the mixture of the waters.

There is a great deal in these reactions and, I believe, a great deal could be said further on the subject, and, if I understand it right, you make a practice to take the paper up at the following meeting?

President Hetzler: No, sir; the discussion is finished here.

Mr. Edgar: Probably it might help me along a little further—as I have no special line of theory to advance except on sugars and tannins, and I believe I have gone as far as possible in explaining why the sodium preparations have all failed—it might help me and help the cause along, if you would ask some questions on the subject, and if I can answer them I will do so; if I cannot, I will say so. I am always looking for new points as well as others, on this subject of boiler treatment. It has been handled by a great many, in the past; they make all kinds of assertions, and I believe there is a great deal for us to find out from practice. There are a great many reactions carried on successfully in the laboratory that we fail to obtain practically; there a great many reactions taking place in nature that it is impossible for us to obtain in the laboratory. I do not know that I can say any more this afternoon, unless it be to answer questions on the subject.

Mr. A. L. Conger (*Locomotive Engineering*): Mr. Edgar spoke of the use of sugar and soda ash; would he have to compound with tannic acid in order to make it work?

Mr. Edgar: You would use the sugar only to reach the sulphate

of lime. It will be well to mix it with tannin. The catechu is best, and can be bought at all the wholesale druggists'.

MR. CONGER: The point I want to raise was, can we introduce sugar into the tenders as we do soda ash, and have it bring away the scale and keep a gypsum scale from forming on the iron of the boiler?

MR. EDGAR: If you use the brown sugar or molasses you would get a very injurious effect on the metal. You have got to use the white "A" sugar; the only available constituent in the sugar cane or beet is the saccharate; that is, the white sugar. Now, the saccharate, or sugar, in the general reaction, is a little too staple, that is, you do not get a readily convertible saccharate; if you mix it with about 10 to 20 per cent mixture of slippery elm and potato starch, or any soluble starch that is capable of boiling into a dextrose sugar, you will increase and bring your results about much more readily.

MR. CONGER: Then if the mixture of sugar and starch, such as you find in the potato after it is once converted, is put into the tank, would that bring out this gypsum scale with the same effect as the soda ash?

MR. EDGAR: Yes.

MR. CONGER: Would it take as many dollars' worth of sugar and starch to go into this compound as it now takes of soda ash?

MR. EDGAR: It will cost twice as much.

MR. CONGER: Then, do you think the expense of twice as much would pay for the advantage we have in the engines not foaming as they do when you use soda ash?

MR. EDGAR: I believe so. You will have to prove that by practical results. You would have to determine by trying it.

MR. CONGER: Of course, having used the soda ash, we know of the troubles incident to it, the boilers foam badly so that it takes more oil for the valves and cylinders and is harder work for the men to haul the trains than if the boiler never foams. Now, if a greater expense in the line of the sugar and starch mixture would produce the same effect without any of the difficulties, the question that I want to solve is, could we use sugar and starch for that purpose and do away with the foaming altogether and still keep out the gypsum scale? You say it will not affect any other kind of scale?

MR. EDGAR: Except the lime as the sulphate.

MR. CONGER: And the carbonate?

Mr. Edgar: It will affect the carbonate also, but the results are not as satisfactory as the action of the tannin on the carbonate of lime.

Mr. Conger: Then, to make it work satisfactory on both carbonate and sulphate, it would require a proportion of tannin, another proportion of sugar, and a third proportion of starch?

Mr. Edgar: Yes, and it is all easily mixed, and the analysis of your water, giving you the percentage of carbonate, should govern your percentage of tannin used, and the percentage of sulphate should govern the percentage of sugar used.

Now, if you are using the tannin extract, always select the catechu, sumach or oak (all of which you can buy at a hundred different places), for the reason that the hemlock and the common tan bark extract, also several imported tannin products from South America, contain such large quantities of volatile oil and resin that they are unfit for boiler purposes, because this resin and volatile oil in boiling water and the high temperature of the steam boiler are high oxidizing agents to the iron and they also impair the action of the tannin. You might have, by your assay, 30 per cent of the tannin in this extract, but the presence of the volatile oil and resinous matter, such as we find in the common tan bark extract, impairs or changes the tannin.

Mr. Manchester: I would like to ask the speaker what becomes of the precipitate, the sludge, and in what form does it shape itself in the boiler, providing it goes into the boiler, and how is it to be taken care of?

Mr. Edgar: Well, if you use all tannate of soda, you would convert your lime into tannate of lime, which would be the sludge, and which has no affinity for the hot metal, and no doubt a great deal of it is formed in but one minute or so. In a very short time after such reaction should take place, it would readily convert into its carbonate but the presence of the excess of tannin would prevent it from adhering as such, and it would remain there as a flocculent sludge, having no affinity for the hot metal.

It is not tenuous, clay-like or heavy in its physical properties, and will not settle nor adhere as a sticky, hard substance, but it is almost of the gravity of the water and it flows readily as it is washed out.

If you use the straight tannate of soda, you would have in exchange a large quantity of sodium carbonate or sodium sulphate in

solution. This would give you quite a density in your boiler water, but where you use a small percentage of tannate of soda and the balance of your tannin is in the form of a tannin extracted matter, giving you an available tannic acid, your soda gives you its possible replacable or exchange base and the soda is displaced by the calcium ; and the sodium, going to the tannic acid, displacing the acid hydrogen of the tannin, giving you tannate of soda.

Now, this is a little deeper and a little further than laboratory practice, and I do not say that I would like to state this all in a manner that I would ask any one of you to believe it, but I would say to the general chemists of the country that we would take it out of the laboratory and into the boilers and in practice follow it up. I believe it will stand theoretically and prove true practically. I also further believe that the average laboratory, the average chemist, has never followed into this particular line from this particular standpoint, and I think there is a great deal for us to find out in the future, so as to enable us to write these reactions to our entire satisfaction. We know that we have never received any real successful results from the different substances used so far, and also know that we have received very satisfactory results from the use of potatoes years ago, and up in the lumbering districts they have used oak logs. You know up in the tanning districts, where the pond water contains lots of strips of bark, they never have any scale.

Now, all practical results and general investigation through the country lead us to believe that there is something to this, and it is worth looking into, and it is not wise for us to take up any of these theories so advanced in a skeptical manner. There may be a great deal in it. I have been eleven or twelve years working on these tannins and sugars. I have been up against, as the boys might say, the practical end of it. I am still learning every day, and hope to be able to do more in the future. I do not wish to be radical in any way, but I do believe that we get a saccharate of lime in the action of sugar ; sugar is carbon, and that we get this lime next into a tartrate, then into an oxalate and down into a complex mixture of carbonates and tannates ; and tannates and carbonates of lime in the presence of a little excess of tannin matter and available carbon, such as sugar, remains as a sludge and is constantly kept as a sludge without any existing affinity whatever for the hot metal, and is readily washed out.

Mr. J. A. Graham: I would like to ask the speaker how long the preparation would have to be in the tank before it should be used in the locomotive?

Mr. Edgar: We could not figure on any reaction whatever in the tank. The lime salts are not soluble in a cold solution of sugar, but in a hot, boiling solution; that is, to our knowledge from practical experience, we must have a boiling solution to get the results. We would get no precipitation in the tank, whatever; if we did, and we took out all the precipitation and delivered to the locomotive or boiler absolutely pure water, we would receive a general action on the iron joints, etc., all of which you will readily understand is the action of too pure water, namely pitting. It is not wise, it is impossible, to deliver a pure water to a boiler, obtaining practical results.

Mr. Graham: The reason I asked that question was that I understood, in your remarks a short time ago, that you said that water should be treated in the tanks at the watering stations.

Mr. Edgar: Yes.

Mr. Graham: What would be the object of treating water in station tanks if it will have no effect on the water until it is put in the boiler?

Mr. Edgar: The object is to get the proper compound in to each feed water. You could not feed a compound very well in the tank on the engine, because you must introduce your specially made preparation to meet the requirement of each water according to volume, so much for each volume of water, so that if the engineer takes 3,000 gallons here and 2,000 gallons farther up, he would have a mixture of water, each one being charged with its own compound, which would be the equivalent for a mixture suitable for the mixed waters (as per analysis) in all proportions. The reactions should all take place in the boiler,—they must take place in the boiler. This sludge that is formed is one of the best preservative agents that you could use in the boiler for the iron. Its presence there furnishes a substance to be attacked, to be used up by the sodium, acidity or natural condition of the water, for the too pure condition of the water to spend its force on, instead of the metal, the same as if we used an acid in the boiler which would attack the metal before it would attack a neutral salt according to chemical affinity.

Mr. Lyman A. Wilcox (L. S. & M. S. Ry.): Will the water

and solution thoroughly mix when you place it in the tank, so it will be thoroughly mixed when it goes to the tank on the engine?

MR. EDGAR: You take your sugars and starches and they should be boiled together. After they are boiled and brought into solution, then the tannin extract is introduced; it should be perfectly soluble in any proportion of water.

MR. WILCOX: I was speaking of the cold water, the water being cold in the tank; when you put your compound, already prepared, into the tank, does it mix readily so that when it is delivered from the tank to the engine, is it thoroughly mixed?

MR. EDGAR: Yes; this substance is all soluble in hot or cold water if it is once boiled together; all solubility comes with your boiling it together; you may make a little thinner extract of it, a little thinner solution of it, and when added to the tank, hot or cold, it is readily soluble, and after it is once soluble it will not precipitate; it will act the same as so much coffee extract.

MR. WILCOX: Then we are to understand that, in preparing this compound, you boil it first, before you put it in the tank?

MR. EDGAR: You naturally would boil any starch before you would get it in soluble condition. You see the point in this theory is that we are using organic acid radicals. We are confining ourselves to the tannin and sugars with as little base as possible, and in our results we practically incorporate our entire mixture. We do not leave an unsatisfied base or an unsatisfied acid radical; we leave an available tannin and an available saccharate. What is not used and taken up is of an inert nature, practically without any effect on the metal.

MR. RHODES: May I ask whether this treatment would have any effect on waters of an alkali nature?

MR. EDGAR: You would naturally use a tannin, and your soda would be converted into a tannate of soda. Now, to prevent the tannate of soda breaking up and acting on the iron, you have a certain amount of this organic matter that a caustic would act on, in case you got any hydrate present; you would prevent any action whatever on the iron, and to prevent foaming, saponification, if you introduce a percentage of slippery elm bark and ground fibre starchy matter, you would have there a substance which would yield up a possible acetic compound that is within the slippery elm bark and all wood fibre pulp. Where waters are very strongly impregnated with

soda salts, if you would introduce some vinegar or acetic acid, or substance that would yield up an acetic acid, you would convert your sodium carbonate, which is the principal ingredient that causes the foaming, into sodium acetate and the slippery elm bark mixed with your other starches would give you in the boiling solution, and the warming up of this substance (at that high degree of heat that you have in the steam boiler), a constant yield of a possible acetic formation sufficient to prevent all such foaming.

Mr. Rhodes: Foaming existent with alkali waters can be prevented?

Mr. Edgar: Yes. If you take soap and water and wash your hands, and then pour in a solution of carbonate of soda, or washing soda, you know how soapy it is; you know how it will suds up. You introduce a little vinegar or a little acetic acid and you will see the astringent action instantly on the soap and the washing of your hands in the water. You cannot possibly make it foam.

Now, if you put an obtainable acetic acid in your boilers with saccharates and other organic radicals, you will prevent the foaming. If you used a straight acid you would injure the iron. We will say this is all theory. I have felt warranted in being ready to advance these theories from practice. I would not ask that they be accepted, but I do not believe they can be contradicted theoretically. And I would state that there may be some chemists that have followed the old routine orthodox chemistry, that have kept in the same old ruts, and I would say to them I believe it would be wise to follow this up practically and see. I do not believe in secrets. I do not think it is possible to have a secret. Everything is pulled apart in the laboratory and the man who has a secret is dangerous.

I never, for my part, would produce any substance, or have anything to do with any substance, unless I knew what it was; unless they were willing to tell me or had a good theoretical explanation to cover it, all of which would necessitate giving the formula.

I advance this line of argument and these theories at the request of the Western Railway Club, and do so hoping that it will open up a new line of thought, and that you will take it as such, not as granted, but prove it practically.

Mr. Wilcox: Do I understand that you could use some sort of a trap, where the sediment could be drawn to, and then be blown off at intervals; simply magnetize it, I might say?

Mr. Edgar : Oh, no ; there is no magnetic attraction or action in these results whatever.

Mr. Wilcox : In speaking of the zinc, I thought you referred to it in that way.

Mr. Edgar : Well, every steam boiler when generating steam, the metal expanding and contracting, is a sort of galvanic battery in itself and when the water is too pure, too inert in its nature, it does act as a battery solution and an electrolite, and the positive pole is invariably destroyed, which is the iron.

Now, in such cases as you find in marine practice, they have substituted a more positive pole by introducing and hanging into the boiler big chunks or square blocks of zinc, and the zinc naturally is destroyed in place of the iron. Now, I said I believe it is wrong ; that is not removing the seat of the trouble ; it is simply furnishing a substitute ; but if we satisfy the water, and keep it in a satisfied condition, so as to offset the solvent properties, why, they will break up every electrolite between their poles and, consequently, they will have no battery.

Mr. Delano : I, for one, am very grateful to Mr. Edgar for the explanation he has made. It seems to me it has opened up a very interesting line of thought indeed.

Mr. Rhodes : We are apparently not discussing this matter very fully. I think it is more because it is late than anything else. I think what Mr. Edgar has said is exceedingly interesting, and many of the statements that he has brought out we can well verify.

I have known for years of potato peelings being used for purifying water, and the subject of pure water is exceedingly interesting to me. I know a few places where we have too pure water, and I know the evil of pitting that is mentioned. I hope the effect of this talk will be to open up a line of investigation, which may produce good results.

I am sorry to hear Mr. Edgar say that his discussion is more theoretical than practical. I had hoped there was a great deal of practical work in connection with it.

Mr. Edgar : I will say, in answer to that, that the reason I said it is theoretical is in consideration to those whom I believe to be skeptical about the results of this. I did it through courtesy. I personally believe it practical ; I believe in every statement that I have made this afternoon, and I believe it from my own personal investi-

gations, my own personal results for years; but not wishing to bring in anything of a personal nature, I have put it that way out of courtesy to those who have different views and who are naturally skeptical on the subject.

MR. WICKHORST (C., B. & Q. R. R.): I would like to have Mr. Edgar explain again the action of slippery elm in overcoming the foaming action of sodium carbonate.

MR. EDGAR: Simply, any substance introduced in the boiler that will yield or give up an acetic acid; this 'acetic formation will break up the carbonate, giving you an acetate, which will give you instead of that soft (let me speak of the physical properties) condition, which will give you an astringent styptic one, and break your sodium carbonate up into an acetate which will prevent the foaming.

MR. DELANO: Can slippery elm be delivered in a solution?

MR. EDGAR: Well, yes; it can be brought down into such a mixture that it can be readily fed into almost any sized pipe without even adhering to the hot surface. It is very soluble and oozy, and readily handled. I thank you.

PRESIDENT HETZLER: I am sure we appreciate Mr. Edgar's remarks, and regret that the lateness of the hour will not permit us to proceed further with the discussion.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

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THE regular monthly meeting of the Western Railway Club was called to order at 2 p. m., Tuesday, Feb. 20, 1900, in the Auditorium Hotel, Chicago. President H. G. Hetzler in the chair.

Following are the names of those who registered:

Anderson, Thos.
Bayley, R. W.
Blanchard, W. A.
Bradeen, J. O.
Bryant, W. E.
Bushnell, R. W.
Cardwell, J. R.
Carney, J. A.
Clark, F. H.
Colville, R. W.
Cooke, Allen
Deems, J. F.
Delano, F. A.
Ettinger, R. L.
Frey, N.
Gardner, J. W.
Gilleland, D. J.
Goehrs, Wm. H.
Gohen, J. A.
Goss, Prof. Wm. F. M.
Graham, J. A.
Haskell, B.
Hayes, Scott R.
Hedrick, Elias
Henderson, G. R.
Henry, C. S.
Herr, E. M.
Hetzler, H. G.
Hill, Jas. W.
Hone, A. C.
Hornish, F. W.
Hubbell, Ira C.
Hyndman, F. T.
Jacoby, W. L.
James, Geo.
Keeler, Sanford
Kerr, Prof. C. V.
Kirby, T. B.
Kirby, W. S.
Lane, F. W.
Lingo, John
Mackenzie, John
Macpherson, A. F.
McAlpine, A. R.
McRae, J. A.
Miller, Wm.
Miller, J. C.
Miller, Geo. F.
Neff, J. P.
Noble, L. C.
Otley, Benj. F.
Otley, Samuel
Pari h, L. G.
Peck, Peter H.
Perry, A. R.
Quereau, C. H.
Raidler, W. P.
Rennolds, Wm. C.
Rhodes, G. W.
Rogers, M. J.
Royal, Geo., Jr.
Sawyer, E. C.
Shea, R. T.
Shillinglaw, T. O.
Smart, Prof. R. A.
Smith, R. D.
Soule, R. H.
Sprague, W. T.
Stark, F. H.
Sullivan, C. L.
Taylor, J. W.
Thompson, E. B.
Tratman, E. E. Russell
Warner, W. T.
Wheeler, Wm. B.
Whitridge, J. C.
Wickhorst, W. H.
Wilcox, L. A.
Willsie, A. N.
Woodman, G. A.
Zeleny, Frank

President Hetzler: The minutes of our last meeting will stand approved, as published, if there are no corrections.

The Secretary will please read the names of new members as approved by the Board of Directors.

The Secretary then read the following:

Benj. F. Otley, Otley Cement Company, Chicago.
Jno. Hodgson, M. C. B., Grand Trunk Ry., Port Huron, Michigan.
R. P. C. Sanderson, Asst. Supt. Mach., A., T. & S. F. Ry., Topeka, Kan.
S. W. Rossiter, Graton & Knight Mfg. Co., 171 So. Canal St., Chicago.
Edward Brankin, N. Z. Graves & Co., Philadelphia, Pa.
B. S. Atkinson, T. M. Arkansas, Louisiana & So. Ry., Minden, La.
W. S. Cozad, Clerk, Master Mechanic, C., B. & Q., LaCrosse, Wisconsin.
A. F. Macpherson, The Cloud Steel Truck Co., Chicago.
Theo. F. Dreyfus, Special Apprentice, Ill. Cent. R. R., Chicago.
C. D. Terrell, Special Apprentice, Ill. Cent. R. R., Chicago.
J. N. Mowrey, Special Apprentice, West Burlington, Iowa.
Lloyd W. Golder, West 40th St. shops, C. & N. W. Ry , Chicago, Ill.
F. J. Smith, D. M. M., B. & O. S. W. Ry., Chillicothe, Ohio.
Harley Roy Crull, Purdue University, Lafayette, Ind.
W. C. Lambert, Round House For., B. & M. R., Edgemont, S. D.
Hugh Gallagher, Loco. Engineer, A., T. & S. F. Ry., Madison, Iowa.
W. T. Warner, Wheel Insp., I. C. R. R., Chicago.
H. R. Linn, L. S. & M. S. Ry., Cleveland, Ohio.
N. Frey, M. M., C. B. & Q., LaCrosse, Wis.
S. J. Bowling, Sec'y, C. B. Hutchins & Sons, Detroit, Mich.
L. H. Turner, S, M. P. & E., P. & L. E. R. R., McKees Rocks, Pa
W. O. Duntley, Chicago Pneumatic Tool Co., Chicago.

President Hetzler: At a meeting of the Board of Directors, this morning, it was decided that a committee be named to consider and report upon the revision of the interchange rules, this committee to report at the April meeting, and the report to be discussed at that meeting. A motion is in order to have this committee appointed.

It was moved by Mr. Haskell that a committee of five be appointed by the chair to take this matter in hand.

Motion carried.

President Hetzler: I will ask the following gentlemen to serve on this committee: Messrs. R. D. Smith, P. H. Peck, C. M. Mileham, Joseph Buker and J. J. Hennessey.

The next in order are the papers of the day. We will first take up Mr. Quereau's paper on "Ton Mile Statistics." I will ask Mr. Quereau to kindly review his paper.

Ton Mile Statistics.

By C. H. Quereau

Ass't Sup't Machinery D. & R. G. R. R.

It seems to be generally admitted that the use of the ton mile basis for motive power statistics is the most practical, encourages economical methods of operating and should be employed, but there seems to be considerable difference of opinion as to the best methods of obtaining ton mileage and of compiling the statistics. The following is offered, not as the best solution of the problem, but with a view of stimulating a study and discussion of this very important matter:

COMPARISON OF STATISTICS.

There seems to be a quite general opinion that it is desirable and advantageous to compare the statistics of one road with those of others in order to improve records, and for this reason the unit of comparison should be one which includes the resistance due to grades. I believe this is entirely unnecessary and impracticable, and will not secure the results to be obtained by comparing the records made by a system, or better still, by a division with its own previous records. That a comparison of the records of one railroad system with others will not secure the desired results, as surely as a comparison of the records of a division with its previous records, seems obvious, from the fact that the records of a system are made from the records of individuals, and that the logical method of improving the general record is to improve the individual records. It is very doubtful if a superintendent of motive power will improve the records of one of his master mechanics by comparing them with those made on the London & North-Western, or White Pass & Yukon Railroad. The obvious reply of the master mechanic will be that conditions are not comparable, and a comparison of results obtained under differing conditions is unreasonable and of little practical value. This line of reasoning will have little force if the records of a system or division are compared with those made by the same line of road previously, for there will either be little difference in the conditions, or their influence can readily be taken into account.

A comparison of the statistics of different roads is impracticable because the elements of speed, fuel, water, motive power, ratings, and prevailing weather conditions may each be as important in influencing results as the grade, and it is very doubtful if anyone would argue that our statistics should contain the necessary information concerning these items, that it would be possible to formulate a basis for our statistics which could contain all these, or, if these facts were given, would care to stake their reputation on the accuracy of the conclusions drawn.

It is urged that general managers compare the statistics of their road with those of others, and therefore, the basis of our statistics should be such as to make the comparison fair. It seems much more logical to conclude that general managers are open to reason and could be convinced that such a basis is impracticable and misleading, and such comparisons of little value, to be used only in the most generous fashion.

FREIGHT SERVICE.

What Tonnage Should Be Included?

There are arguments both for and against including the weight of the engine and way car in the tonnage. From a motive power standpoint, it seems important to credit the engines and enginemen with all the work done, which certainly includes that absorbed by the engine and the caboose. Unless this is done there will be no ton mile credit in the case of an engine running light, or with only a way car, and we know that under these circumstances the consumption of coal per ton mile is greater than under other ordinary service conditions. Nor does it seem logical to charge coal and supplies, which must be done, without crediting the work performed by them.

On the other hand, the general manager is especially interested in knowing the cost per ton mile of hauling the net freight, almost regardless of the ton of the cars, engine and caboose, and this is considered by some as sufficient warrant for not including in the tonnage the weights of the engine and way car, which do not carry freight.

It would manifestly be illogical and unfair to determine the tonnage of only the revenue freight in a train, or of only the freight in the cars, whether revenue or non-revenue, as a basis for motive power statistics, as this would give no measure of the work done and there would be no credit of ton mileage from a train of empties, and would nullify the special claim of merit for the ton mile basis that it is more accurate than the mile basis. The logical outcome of this line of reasoning would include the weight of the entire train, which surely must include the engine and way car.

Only by including the weight of the entire train can any shadow of a reasonable comparison be made between divisions or systems having heavy grades and those with comparatively light grades. On the Denver & Rio Grande, owing to the grades, the engine and way car will average about 20 per cent of the weight of the entire train, while on a number of grades and for considerable distances they will average 35 per cent of the total tonnage. On the Burlington road in Illinois and for a large portion of Nebraska, the proportion of the total weight of their freight trains made up by the engine and caboose is only 10 per cent, and very frequently but 8.7 per cent. It seems hardly reasonable to omit from the ton mileage so large a proportion of the credit for the work done as 20 per cent and expect to draw conclusions, even approximating accuracy, as to the efficiency of the motive power department, or even so small a proportion as 10 per cent. Nor do I believe that a progressive general manager would disagree with these conclusions, if properly presented, or fail to realize the importance of economical methods in managing this department and the necessity of accurate statistics to accomplish this end.

I see no good reason why, with proper forms and a slight additional expense, ton mile statistics cannot be compiled so as to give the ton mileage of the whole train for the benefit of the motive power department, and of the contents of the cars for the operating department. The monthly expense for compiling the ton mileage statistics on a road operating more than 3,500 miles of track is $85.00 ; an amount too small to be considered when compared with the benefits resulting, even

if doubled. It seems very desirable that both the gross and net ton mileage should be kept, as there can be little doubt that a comparison of these figures would result in increasing the tons of lading per car and reduce empty car mileage and helper engine mileage, thus reducing operating expenses.

HOW SHOULD TONNAGE BE DETERMINED?

There are roads where the tonnage rating of engines is nominally in force, but in practice it is assumed that a given number of cars of a given series weighs so many tons, the reason given for this practice being the assumption that a more accurate method of determining the weight of trains would involve a useless expense. That this assumption is not well founded seems evident from the fact that this is practically the obsolete car rating method, which has been abandoned as too expensive by practically all the trunk lines, because experience has shown that their locomotives were under loaded by the car rating practice. Most railroads using the tonnage rating determine the weights of their trains by taking the weights of the lading from the bills, and of the cars from the weight stenciled on them. This is undoubtedly much better than the plan just mentioned, and has been found from experience to be decidedly better than the older plan of car rating, but lacks considerable of giving as accurate results as are desirable, as it is a notorious fact, that the stenciled weights are not by any means accurate, and those on the way bills but little, if any, more so.

The use of self-registering scales has so extended within recent years, and the expense is so moderate, that it would seem that the actual gross weights of the cars could be obtained without prohibitive expense, and would pay in a decrease in overtime and doubling because of overloaded engines. It is also probable it would result in an increase in tonnage ratings, as the present prevailing practice of getting train weights undoubtedly results in more cases of doubling than would occur if accurate weights were to be had, and cases of doubling undoubtedly have a tendency to reduce tonnage ratings.

The following comparison of train weights as usually taken, under the head of billed and marked weights, and thc actual train weights as determined by track scales, in the column actual weights, shows a considerable variation, especially in the case of stock cars:

Date.	Empties.	Loads.	Billed and Marked Weights in Tons.	Actual Weight in Tons.	Difference in Weights in Tons.	Remarks.
Oct. 14	34		446.77	446.70	-0.07	
Oct. 17	33		461.75	464.05	2.30	
Oct. 20	25	3	426.20	452.90	26.70	11 Stock
Oct. 23	15	8	437 15	459.35	22.20	3 Stock
Oct. 24	28		436.35	445.30	8.45	11 Stock
Oct. 28	29	1	444.60	456.90	12.30	12 Stock
Oct. 29		23	861.42	857.90	-3.52	
Nov. 8	30	1	446.75	457.40	10.65	
Nov. 10		24	821.85	840.50	18.65	
Nov. 11	25		374.125	443.30	69.175	17 Stock
Nov. 14	3	21	837.60	845.20	7.65	
Nov. 15	18	4	423.70	456.55	32.85	14 Stock
Nov. 17	2	23	853.25	852.55	-0.70	
Nov. 18	30		425.40	459.05	33.65	12 Stock
Nov. 19	1	26	866.10	865.70	-0.40	
Dec. 1	26	3	492.00	503.00	11.00	
Dec. 2		26	877.50	879.95	2.45	
Dec. 3	20	6	465.35	504.10	38.75	6 Stock
Dec. 4		24	876.05	870.75	-5.30	
Dec. 5	16	8	500.90	496.55	-4.35	
Dec. 6		24	876.675	897.45	20.77	

I believe that a sufficient allowance for the weight of the bedding in stock cars is usually not made, and this fact will account for a considerable number of cases of doubling. Frequently this bedding will weigh five tons per car. Assuming that it averages three tons per car, this would amount to sixty tons, the equivalent of four cars, in a train of twenty cars, and to one hundred and fifty tons, equal to ten cars, in a train of fifty cars. An item which should be taken into account, and would be if the cars were weighed.

The weight of the locomotive in working order, and of the tender filled to half its capacity with coal and water, should be used.

TONNAGE OF EMPTY CARS.

Those who have studied the matter are well aware that a given tonnage of empty cars requires considerably more power than when concentrated in loaded cars, especially on level track, and at speeds more than moderate, while on grades and at slow speeds the difference is small.

In 1895 a series of tests was made on the Chicago, Burlington & Quincy R. R., to determine the relative resistance of a given weight of train in empties, and then with fully loaded cars; a test being made with each train on a half per cent grade and then on a comparatively level track. These tests were in charge of Wm. Forsyth, the trains carefully weighed and the train resistance determined by a dynamometer car; the weather conditions were comparatively uniform. The results showed that on the grade, at a speed of ten miles per hour, the empty cars pulled 7 per cent harder than the same weight in loads; while, on the level track, at a speed of twenty-five miles an hour, the empties required 56 per cent more power than the loads. Tests were also made with the cars two-thirds and then one-third

loaded, which showed that, as the gross weight of the car decreased, the power per ton required to pull it increased.

In January, 1897, a series of tests was made on the Burlington & Missouri River Railroad under the supervision of the writer, with carefully weighed trains and a dynamometer car. The cars used in the test trains had all been in service for some time, so that there was no unusual friction on the journals. Moreover, the journals were all carefully oiled. The tests were made with both trains on a grade one-half of 1 per cent, and on comparatively level track, the weather conditions being practically uniform for both tests, the thermometer registering 50 for the loaded cars and 57 for the empty. In the test on the grade the speed of the loaded train was 12.2 miles per hour, and with the empty train 12.8 miles per hour; the empty train pulled 7 per cent harder per ton than the loaded train. Both trains consisted of box cars. On the level track, at a speed of 21 miles per hour for the loads and 22.2 miles per hour for the empties, the latter required 58 per cent more power. The track over which these tests were made had no curves sharper than 2 degrees. Had there been more and sharper curves and considerable wind, it seems reasonable to believe the difference would have been appreciably greater.

Tests were also made with loaded box cars when the temperature was 6 degrees above zero, the speed on the grade being 10.4 miles per hour, and on the level track 23.4 miles per hour. Notwithstanding the fact that the train had run ten miles before the records for the test on the grade were made, so that there was this opportunity for warming up the waste in the boxes, the resistance per ton of train was 40 per cent greater than when the temperature was 50 degrees. After the train had run about thirty miles the difference decreased to 24 per cent.

It is evident from the preceding that, if ton mile statistics are to be anywhere near accurate, there should be an allowance made, increasing the tonnage of any empty car in proportion to the greater power necessary to haul it when compared to that necessary for a fully loaded car. The question which will at once present itself will be, how much? It seems evident that the increase will be, or should be, different for almost every road. If the profile of the road is such as the D. & R. G. has, where the grade is up hill practically half the time and down hill the other half, the above figures would indicate that the actual weight of an empty car should be increased 7 per cent in rating locomotives and figuring ton mileage. On the Burlington, between Chicago and the Mississippi river, where the grades are comparatively light, and the speeds relatively high, approximately 50 per cent should be added to the weights of empty cars in order to get a proper credit for the work expended in hauling them, compared with loaded cars. On the Burlington in Iowa, west of Creston, where there are numerous grades, several more than 1 per cent, comparatively little level track and numerous curves, the credit for empty cars should be 7 per cent, as on the D. & R. G.

The facts presented showing the effect of temperature, speed, and the gross weight of each car on the power required to haul a given tonnage, furnish additional proof that it is unwise to expect to make a fair comparison of the motive power records on two roads, except when all conditions on both are practically identical, a state of facts rarely, if ever, found.

PASSENGER SERVICE.

The claim has been made that it is better to have the motive power statistics for passenger service compiled on the mile, instead of ton mile basis, because the division superintendent and the master mechanic have no control of the weight or speeds of these trains. These objections apply to freight service with almost equal force in so far as speed is concerned, and on a number of roads which handle considerable amounts of perishable freight, the weight of these trains, which is limited by the speed required, is controlled almost entirely by competitive considerations. It seems to me that the advantages to be obtained by the use of the ton mile basis are the same for passenger as freight service, namely, that it furnished a more nearly accurate measure of the work done than the mile basis, and the more accurate the credit for work performed the more intelligently can we reduce the debit of expense.

SWITCH AND WORK TRAIN SERVICE.

It is customary to credit switch and work engines with an arbitrary number of miles per hour of service, giving the same credit whether at work or standing still. This was done, no doubt, in order that they might have some credit against which to charge the debit of supplies, wages and repairs, and only as a rough approximation. It seems to me that, so far as work train engines are concerned, there is no difficulty in crediting them with the actual ton mileage earned, and that this will give a much more nearly accurate measure of the work performed by them than any arbitrary number of miles for each hour they are in service.

For switch engines I see no good reason why they cannot be credited with arbitrary ton mileage, as well as mileage only, but believe that a simple plan can be developed by which they will be credited with ton mileage which shall depend on the ton mileage of the road engines entering the yard at which the switch engines work. In other words, the ton mileage of the switch engines will be proportional to the ton mileage of the road engines.

PUSHER SERVICE AND DOUBLEHEADING.

The credit for ton mileage for pusher and doubleheading engines should be made on the basis of the proportional power of the engines attached to the train. This is quite easily determined by means of a table which can be made out in the drawing room, from the formula $T=\frac{d^2\,p\,s}{D}$, in which T is the tractive power; d is the diameter of the cylinder; p is the boiler pressure; s is the stroke; and D is the outside diameter of the drivers; all the dimensions in inches and the pressure in pounds.

A sample of such a table, in use on a western road is given herewith, the percentages being even multiples of 5, for convenience in calculations.

GROUPING TON MILEAGE STATISTICS.

The element of speed has a decided influence on the amount of coal used per ton mile. If it were practicable to include this in the basis for motive power statistics, it would add considerable to their accuracy. As this is impossible, it will add materially to the usefulness of the ton mile statistics if the different classes of loco-

A. & B. R. R.

PROPORTIONAL POWER OF LOCOMOTIVES.

CLASS	A$^{17'}$.			A$^{18'}$.			B.			C.			D.			E.			G.			H.			K.		
	PER CENT	WITH CLASS	PER CENT	PER CENT	WITH CLASS	PER CENT	PER CENT	WITH CLASS	PER CENT	PER CENT	WITH CLASS	PER CENT	PER CENT	WITH CLASS	PER CENT	PER CENT	WITH CLASS	PER CENT	PER CENT	WITH CLASS	PER CENT	PER CENT	WITH CLASS	PER CENT	PER CENT	WITH CLASS	PER CENT
	45	A^{18}	55																								
	55	B	45	60	B	40																					
	60	C	40	60	C	40	50	C	50																		
	35	D	65	40	D	60	30	D	70	30	D	70															
	50	E	50	50	E	50	45	E	55	40	E	60	65	E	35												
	40	G	60	45	G	55	35	G	65	35	G	65	55	G	45	40	G	60									
	45	H	55	45	H	55	40	H	60	35	H	65	60	H	40	45	H	55	50	H	50						
	45	K	55	45	K	55	40	K	60	35	K	65	60	K	40	45	K	55	50	K	50	50	K	50			
	25	L	75	30	L	70	20	L	80	20	L	80	40	L	60	25	L	75	35	L	65	30	L	70	30	L	70

motive service are grouped by themselves; all the passenger, freight, helper, work and switch engine records being compiled, each in a group of its own.

I also believe it is wise to separate the main line and branches, as the work on the branches is different from that on the main line, and controlled very largely by local conditions, both as to speed and the work done. Moreover, the branch engines are usually of more antiquated patterns than those on the main line.

CONCLUSIONS.

Better results will be obtained by comparing the records of a system with those previously made by the same system, rather than with those made by another road; and still better results will be had if the comparison is confined to divisions. Admitting this to be a just conclusion, it follows that the basis of statistics need not be such as to make a comparison of the statistics of different roads a fair one, which simplifies the keeping and comparing of records very much.

The tonnage included in computing ton mileage should be the weight of the entire train.

The tonnage of the cars in a train should be determined by actual weighing, while that of the engine should be its weight in working order with tender half full of coal and water.

The tonnage of empty cars should be a certain per cent greater than their actual weight, this per cent to be determined by local conditions.

The tonnage ratings for winter should be less than those for summer.

The ton mile should be the basis for statistics of all classes of engine service.

It is advisable to group the ton mile statistics, each service by itself.

It is also advisable to separate the ton mile statistics of branch lines from main line statistics.

Mr. C. H. Quereau (D. & R. G. R. R.): I wish to preface what I may say in reviewing this paper, by a statement that I do not profess to know anything, except in a very general way, about this subject; that I am convinced there is considerable room for more study before we can come to any final conclusion. I do not know that I am at all certain that the arguments advanced in the paper are conclusive, but I hope that they will draw out expressions of opinion from the members.

It might be well to review these topics very briefly. The first one is "comparison of statistics." I am thoroughly convinced that it does not pay to compare statistics from other roads, except in a general way, with a view of reducing expenses. I am speaking now from the motive power standpoint. The conditions as to power, grade, equipment of all kinds, water temperature and other matters, which might easily be thought of, and which might make a long list, very frequently affect the cost of operating the motive power department

very seriously. So long as that is true, it seems to me an unwise thing to undertake to better present conditions by comparing the statistics of one road with those of another.

This objection is lost if we will compare the statistics of our own road with those made by our own road at some previous period; for instance, if the statistics for January, 1900, are compared with the statistics of January, 1899, on the same road; or, better still, on the same division. There are very few roads in which even two divisions can be thoroughly compared, because grades are different, the volume of business to be handled is different, the motive power is different, the water conditions are different.

The next topic is "What tonnage should be included?" There is room for considerable argument, with a good basis of facts on both sides, as to what tonnage should be included in making the ton mileage statistics on any road. Some argue that only the weight of the cars and their contents should be included. Personally, at present, I can see no good basis for this conclusion. The tonnage statistics should either include the gross weight of the train, including the locomotive and the way car, or they should be the net tonnage in the cars. A compromise between the two, it seems to me, has no advantage for any department. It seems reasonable to assume that the total work done by the locomotive should be the credit against which expenses of wages, supplies, repairs, etc., should be charged. That certainly should include the weight of the locomotive and its tender and of the car. From an operating standpoint, the cost of hauling the freight contained in the cars is the vital point; now a compromise between the two, which would include the gross weight of the car and leave out the way car and engine, would leave no good ground for support.

It seems to me that the proper solution of the difficulty is to keep ton mile statistics for both the motive power department and the operating department, that is, keep the gross tonnage of the train, and also determine the net tonnage—and by net tonnage I mean the lading in the cars. This can be done at a very small expense. It simply means that the net tonnage should be put in one column and the gross tonnage in another column, and it means two footings instead of one. Possibly, it means two sets of figures instead of one, but the increase in expense will be very small. I have some figures which interest me, and I presume will interest some of you, as to the

cost of determining ton mileage. These do not include the making up of the statements in the superintendent of motive power's office, or master mechanic's office, but simply the cost of collecting ton mile figures, from which the master mechanic or superintendent of motive power, or whoever the official may be, will compile these ton mileage statistics.

These figures are for the year 1899, on a road having over 3,500 miles of track. In freight service the cost for 1,000,000 car miles was $9.60. To put it in a little different way, the cost for each train was two cents, which is a figure insignificant in my mind compared with the benefits which will accrue. I do not know that I have made this perfectly clear. The total cost in the way of salaries and clerks was divided by the total number of trains operated during the year 1899, and the resulting figure is the cost of two cents per train. In passenger service the cost for compiling these statistics was $5.88 per 1,000,000 car miles; cost per train was one-third of a cent, so that so far as the cost of getting ton mile statistics is concerned, it should not be prohibitory.

The third topic is, "How should tonnage be determined?" Under this heading, the suggestion is made that it should be actual weights of cars and locomotives, and that it should be determined by the use of a track scale, such as is used very commonly now in weighing stock trains, both loaded and light, and other cars. This is offered simply as a suggestion, I do not know that it is practicable. It would probably mean a track scale at each end of the yard for the main lead, going from there to the main line. As to whether the railroad could afford such expense or not, would depend very largely, I presume, on how many cars are handled and how large the yard is, but if it is practicable, and the expense is not too great, it seems to me that is the proper way of determining the weights on cars for getting the tonnage.

On the fourth page we have the topic, "tonnage of empty cars." There probably will be a great deal of discussion and difference of opinion on that, with sound arguments on both sides. It is well known by those who have studied the matter, that a ton of empty cars requires considerably more power to haul it over the track than a ton of loaded cars. And, furthermore, which may not be so commonly known, it is a well established fact that a hundred thousand capacity car requires less power per ton to haul than a thirty-ton, or

any lower capacity car. That will introduce a complication which I am inclined to think ought to be taken into consideration in this matter, and yet I am not prepared to say what the solution would be. The suggestion is that for empty cars the tonnage should be increased an arbitrary percentage, depending on the grade, etc. The experiments referred to show that on a level grade, approximately at a speed of thirty miles an hour, it requires 50 per cent more power to haul a ton of empty cars than a ton of loaded cars, while on a grade the increase in power at a speed of ten to twelve miles an hour is about 7 per cent for the empty car. The suggestion is made that an arbitrary percentage should be added to the weight of the empty cars in arriving at not only the tonnage rating for locomotives, but also which would be involved in the first, in making the ton mile statistics.

On page No. 6 is a paragraph headed, "passenger service." There seems to be the idea held by some that there is very little value in using ton mile statistics in passenger service. It seems to me that that is a wrong view to take of the matter. Our statistics should determine correctly, or, at least, as correctly as is practicable, the cost of passenger service as well as of freight service. It is argued that because the speed and the train weights, which very largely influence the cost per ton mile of operating, are not under the control of the motive power department in passenger service, therefore, passenger service statistics should not be on the ton mile basis; but I believe that the same thing applies very largely to freight service. Undoubtedly it does to the refrigerator service, where competition determines the speed, and the speed determines the number of cars that can be handled on the train.

I will read the conclusions of the paper for the benefit of those who have not had the time to read it, with the hope of having an interesting discussion.

The conclusions on page 8 are: "Better results will be obtained by comparing the records of a system with those previously made by the same system, rather than with those made by another road; and still better results will be had if the comparison is confined to divisions. Admitting this to be a just conclusion, it follows that the basis of statistics need not be such as to make a comparison of the statistics of different roads a fair one, which simplifies the keeping and comparing of records very much.

"The tonnage included in computing ton mileage should be the

weight of the entire train," which, of course, would include the engine and way car.

"The tonnage of the cars in a train should be determined by actual weighing, while that of the engine should be its weight in working order with tender half full of coal and water." That is on the assumption that the engine averages half a tank of water and half its total capacity of coal over the division.

"The tonnage of empty cars should be a certain per cent greater than their actual weight, this per cent to be determined by local conditions.

"The tonnage ratings for winter should be less than those for the summer.

"The ton mile should be the basis for statistics of all classes of engine service.

"It is advisable to group the ton mileage statistics, each service by itself.

"It is also advisable to separate the ton mile statistics of branch lines, from main line statistics."

President Hetzler: Mr. Quereau's paper is of general interest, both to the operating and motive power departments of the railroads, and I hope that the time will be thoroughly occupied in discussion. Discussion is now in order.

Mr. G. R. Henderson (C. & N. W. Ry.): I think we are all very much interested, Mr. President, in this subject of ton mile statistics. It has been a very interesting one to me, indeed, and I am glad that Mr. Quereau has taken the matter up in the way in which he has. As a general thing, I am inclined to agree with him in regard to what he said in the commencement of his remarks. Undoubtedly it is almost worthless to compare statistics with different railroads, or even different divisions of the same system, on account of the different conditions. We must consider the effect of grade, temperature, different classes of engines and track, and many other conditions. It is almost impossible to get any valuable information by comparing, and I think that the idea has largely gone into disuse, and that more attention is now being paid to comparing statistics of one month with another month, or the year previous, in order to compare the effects of enlargement of motive power, or other changes introduced. I think that does not require any discussion, but I would like to endorse very heartily what Mr. Quereau says.

In regard to what tonnage should be included, I must differ a little from Mr. Quereau. The work that the locomotive does is partly in pulling itself, you might say, but it is a fact that the best designed locomotive will pull more weight behind the tender, that is, the best designed locomotive is that which has the greatest power with the least weight. Now, let us consider two engines of the same steam pressure and the same size cylinders and wheels ; they would both have the same tractive force, and if we were to figure on the weight, including the engine and tender, they would each pull the same amount and would each be esteemed equally good engines. But if one engine, by the benefits of more modern design, we will say, is 20,000 pounds lighter than the other, of course it would be in favor of its tonnage, and it seems to me it would be only just to let the engine have the benefit of it and take the weight behind the tender.

I think Mr. Quereau will see what I mean—if we have an engine that is of more modern design, a better design, it will haul more weight behind the tender than another engine which may be just as powerful, taken from a cylinder standpoint. I think that is worth considering, as it is of more importance to know, in regard to any engine, what we are getting out of it in pulling than as a heat machine.

Now, the point which Mr. Quereau makes in regard to the statistics, in having total and net ton mileage separated, I think that is very beneficial. Of course, the general officers are interested in what the net mileage is, while the motive power department is more interested in the total ton mileage, and I think it would be a very good plan to have the total ton mileage and net, or revenue ton mileage, kept entirely separate.

The plan suggested in regard to weighing each train, of course, is admirable, and it would be most desirable, but I am afraid there would be so many practical difficulties in the way that it would be almost impossible. In other words, if we were to submit a plan that would require a lot of track scales, I think the question would likely be turned down on the first instance. It would be a good plan to do it, but it is almost impracticable.

In regard to the tonnage of empty cars, I would like to say that the committee (of which I was chairman a year or two ago) of the Master Mechanics' Association, appointed for the purpose of investigating that subject, gave the following formula for the percentage

which was to be allowed on empty cars. It depended on grades, and I think that is a pretty fair way to establish it. The formula was:

$$e=\frac{1.8}{y+6}$$

where "e" was the proportionate increase in resistance and "y" was the resistance due to grade. That is, on a level. This formula gave about 30 per cent increase in resistance of empty cars over loaded cars, in tons, and on grades the resistance decreased as the grade increased, as this formula, dividing 1.8 by resistance of grade plus 6 would make allowance for the steeper grade, and the less the effect it would have on empty cars, which made a convenient method, because it was stated merely in percentages, and it could be worked so that when there was a grade of a certain per cent the despatcher would add 5 or 3 per cent to the weight of the train, and as that was constant for any one grade, they could have a list of the grades on the division and could decrease the loads 3 or 5 per cent, whatever the factor was, corresponding to the grade.

There is another point in regard to the ton mileage which is suggested here, but not entered into very thoroughly. Of course a good many of us are now keeping fuel records on the ton mileage, but I think it is just as interesting to keep the lubrication and the repair account on this mileage basis. We had a case the other day where a master mechanic seemed to be quite delighted with the fact that he had the lowest consumption of oil per engine mile of any in that division. I simply got out a little memorandum book that I had, and I showed him that while it was a fact that he had the lowest consumption per engine mile, that the tonnage hauled was so much less that the amount of oil per ton mile was precisely the same in each case; and I think we have every reason to expect that, in a greater or less degree, the increase in the size of our engines and naturally, also, in the size of the journals and the weights becoming greater, we must expect more lubrication necessary. At the same time those engines are expected to haul higher tonnage. If they do not, we have made a bad investment. But though large engines may decrease engine miles per pint of oil, yet if they show an increased ton mileage, I think we have every reason to be satisfied with our showing, and I think that this may explain some apparently unexplainable increases in lubrication.

Mr. J. F. Deems (C., B. & Q. R. R.): I do not know, Mr.

President, that I have anything to add to what has already been said. While the ton mile basis for motive power statistics, or, in fact, any other statistics, is manifestly quite defective, I presume it is the best practicable unit that we can get; but in discussing this question it reminds me of what Prof. Breckinridge said one day about some subject that we had under discussion,—he said it had as many sides to it as a globe, and this is almost the same.

I certainly agree with what Mr. Quereau says about the impossibility of making anything like an intelligent comparison between different roads, and that is doubtless equally true as between different divisions of the same road, and I do not know just how much better off we are when we come to make comparison between any one division of the same road from year to year. Perhaps somewhat better, but there is hardly a year passes by that there is not sufficient change in the capacity of the cars handled, and in the engines, and perhaps in the grades over a given division to make it necessary to figure that very carefully, or the statistics, as collected, will be misleading.

In the matter of loads and empties, it seems to me that is a matter that needs to be considered very carefully; and another point that has occurred to me is, you take a division over which the gradients are mostly in one direction, perhaps giving a rise of some seven or eight hundred feet in 150 miles. We will say one month in 1899 the traffic may be ascending the grade, while in 1900 the bulk of it would be descending; that is an element that will affect the results very materially, and unless it is watched closely the statistics collected would be decidedly misleading.

I recall a matter that was brought to my attention some time ago. One of the large trunk lines had been giving a great deal of attention to increasing the train rating, with a very marked success so far as the increase of the load was concerned, but the first thing they knew one of their competitors was getting most of the stock and time freight. Then the traffic department woke up and got after the operating department, and the result was a very marked reduction in train rating and increase in speed. That would vitiate any figures which might be collected.

There are so many things that belong in statistics of that kind that it seems to me the very best we can do in ton mile statistics is for every one to be watched very carefully. Yet I do not mean to say that they should not be collected, neither do I mean to say

that they should not be consulted, nor do I mean to say that we should not be in a measure guided by them, but for all these the factors or items by which the statistics are influenced have to be watched very closely.

I know of a place where they recently have been showing diagrams to secure this showing graphically for oil. They give each engineer a space on a big card, perhaps eight or ten feet square, and show his oil record in that way, which occurred to me, when I saw it, as being a very good thing. I think it appeals to the enginemen more quickly, perhaps, than it does to put down figures.

I notice something here that I am free to confess I cannot see how you are going to do it. Mr. Quereau says it is customary to credit switch engines with an arbitrary mileage, etc., and then he refers to work train service. I am really unable to see how it will be profitable to get anything like a proper ton mile basis for work train engines with the character of work they are engaged in. It would be possible with the switch engines by simply taking the arbitrary mileage that is adopted, but I cannot see how it can be done for the work train engine. You can get a figure, I admit, but the question is, how reliable is it?

Mr. G. W. Rhodes (B. & M. R. R.): Mr. Chairman, this subject of ton mile statistics is one that I have watched with some little interest and with a good deal of disappointment, at first, because it necessarily changes our well established basis of comparison, viz., cars hauled one mile, or as more commonly expressed, car mile unit. It seems to me some of us consider the metric system in the same way; we do not want to learn a lot of things over again, and therefore we would rather have our present system continued. When the ton mile statistics for motive power came up, I at once saw that the question of what it cost per engine mile, per loaded car mile and for data that we are tolerably familiar with, would be lost; that our past history would be lost in so far as comparisons were concerned, and that we would have to start off with new statistics, and for that reason I have kept rather quiet on the subject and not said very much either in favor of or against it. At the same time, I felt every day, with the increasing differences in car capacities the car unit was becoming more and more incorrect, and that the inevitable result was the ton unit. We have cars now varying in capacity all the way from fifteen tons up to fifty tons. It must be apparent that this car unit

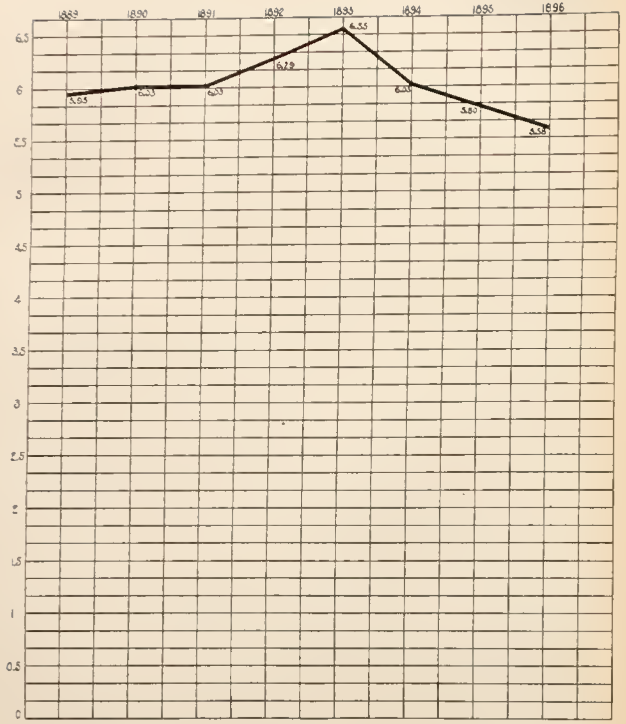


Fig. 1.

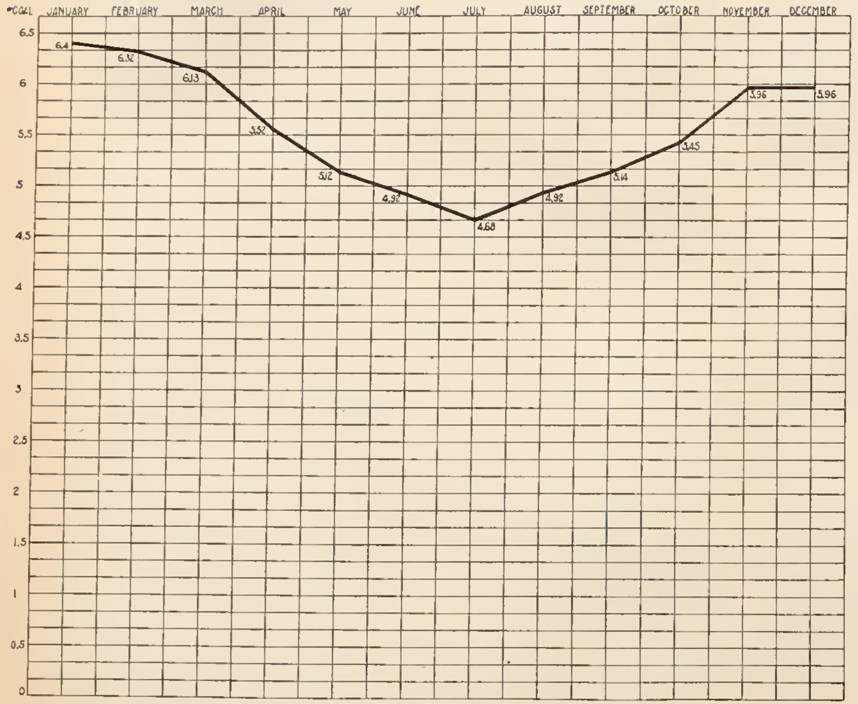


Fig 2

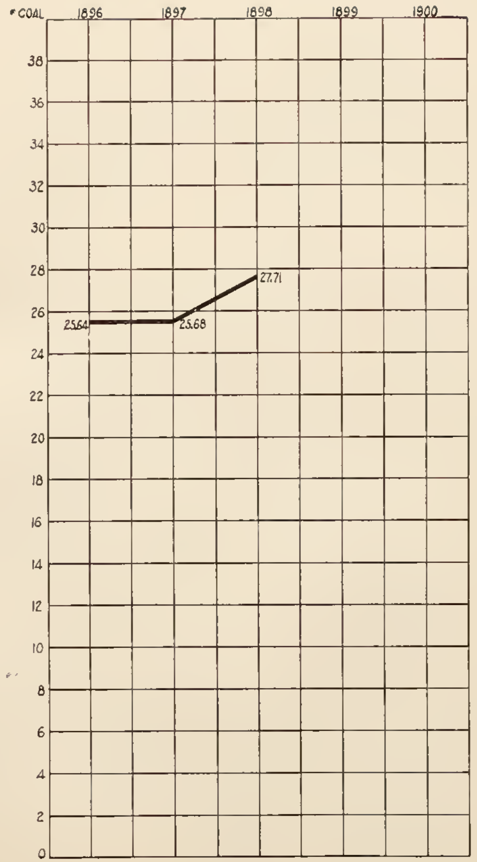


Fig 3.

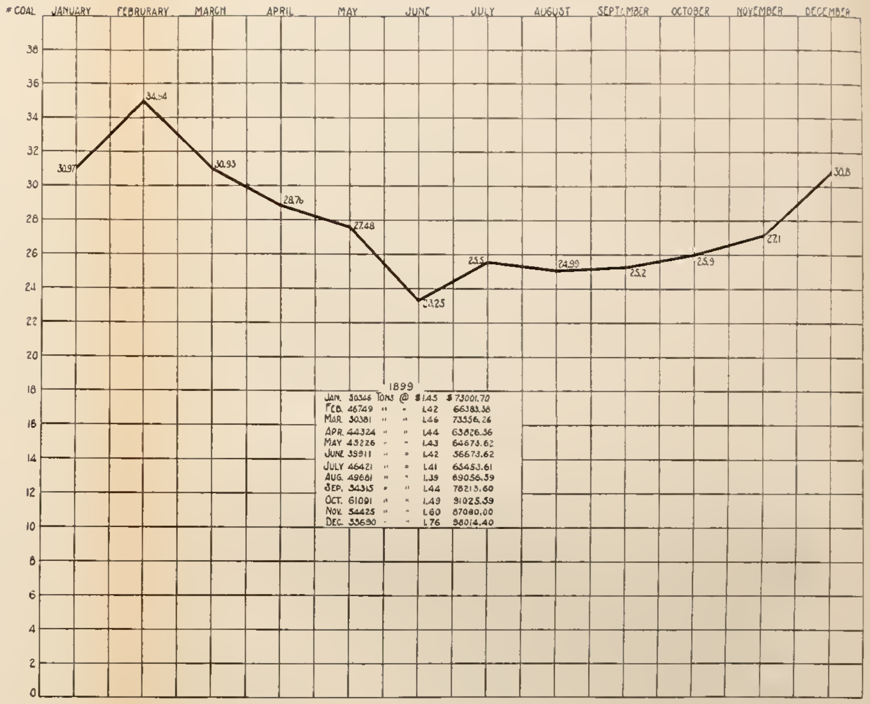


Fig 4

cannot be used any longer to measure our performance by. I believe, moreover, that a few years ago the cost of operating railroads was not as important a consideration as it is today; there were comparatively few railroads and the returns were so good that the officer who was able to get his train between terminals on time, was the successful railroad man. But I believe that nowadays the men who are going to be successful railroad men will be those who not only get their trains through on time, but, incidentally, get there as cheap as their neighbors, and the man who does not know what it costs him to get between terminals promptly and on time is not going to have the same advantage as the one who does know when he gets there what it costs him. Therefore, it seems to me, if this is a fair statement of the case, it would seem that one of the essentials is to get a unit which will not deceive us, and I do not see how we can adopt anything better than this ton unit.

I have brought some diagrams showing one of the cost items in the operation of locomotive trains viz., the coal consumption. Diagrams Figs. 1 and 2 show the coal consumption of the Burlington road (the C., B. & Q. proper), on a loaded car basis. Diagrams Figs. 3 and 4 show the same information for the lines west of the Missouri river on a one hundred ton mile basis. I will first explain the pounds of coal per loaded car mile diagrams, Figs. 1 and 2.

Fig. 1 is what I would call the historical record on the Burlington road. Fig. 2 is a monthly record for one year, for the year 1892. Our datum line here is the bottom of the diagram. The first three squares vertically represent a half pound, six squares one pound, until we get 5.95 pounds. Each two of these squares horizontally represents a year; 5.95 is an average of the pounds of coal consumed per loaded car hauled one mile during the year 1889, that is, passenger and freight included. We started in 1889 with 5.95 pounds of coal per loaded car hauled one mile; then increased up to the year 1893, the World's Fair year, when business was not good and the train loads the engines were pulling, probably were not what they ought to have been, it got up as high as 6.55. Since then, till the year 1896, the record has greatly improved, reaching 5.58 in 1896. The significance of these figures will be appreciated, when I state that it has been estimated that the saving of one pound of coal per car per mile on the C., B. & Q. is the equivalent of $100,000 in a year.

It is, however, well known that the capacity of the cars has largely increased, and with a variable unit such comparisons lose much of their force. The Burlington system abandoned its loaded car unit, and as far as coal is concerned has adopted the 100-ton mile unit.

Fig. 2 is the monthly record for the year 1892, from which this historical record is compiled. What I want to call special attention to, is the tolerably close comparison between the car mile monthly diagram (Fig. 2) and the 100-ton mile monthly diagram (Fig. 4). In the winter months we start in with 6.4, then as we come to the warmer summer months it is as low as 4.68, then increases again with the colder winter months to 5.96 pounds per car per mile.

Now, let us notice the one hundred ton miles on the B. & M. road. We have had that written now for four years. In 1896 we consumed about 25.64 tons of coal per one hundred ton miles ; in 1897 it was about the same, about 25.68 pounds of coal ; in 1898 the figures went up to 27½ ; 1899 is not figured out yet, but from the 1899 monthly diagram (Fig. 4) I infer that it will be about 26½ pounds of coal per hundred ton miles, which in dollars and cents represents a saving of about $34,000 over the figures of 1898.

Now, we will look at this monthly sheet, Fig. 4. In January the consumption was very nearly thirty-one pounds of coal per hundred ton mile ; in February, which was the extreme cold month of last year (in the western part of the country the thermometer went down in some cases to 50 degrees below zero), the consumption got up to thirty-four pounds of coal per one hundred ton miles. See what a gradual improvement there has been since. The same kind of dip during the warmer months, as is shown in Fig 2, and clearly emphasizing the importance of protecting boilers from cold weather with good lagging. Just what produced this June dip I do not know. It may be it was a dip in the accounting department figures rather than due to any special excellence of the engines or those responsible for their operation.

Diagrams 3 and 4 are on a different vertical scale. Each square is two pounds, but you will observe the shape of the diagram (Fig. 4) is much the same as Fig. 2. This has been very satisfactory on our road, because we believe it is much more accurate than any diagrams of this kind would be on a car mile basis, and during the coming year, in constructing our new diagrams, we will be able to see at once the effect of any improvements which we may make.

On page 6 of Mr. Quereau's paper, he speaks about the importance of having the passenger and freight service equally maintained; that it is of equal importance to have the passenger tonnage as the freight tonnage. There has been a great deal of talk lately about the cost of handling fast freight trains. I think that if passenger and freight engine statements are kept separately it will help very materially in explaining to railroad managers what high speed trains mean.

On the loaded car mile basis, freight trains ought to be hauled for in the neighborhood of four pounds of coal per loaded car per mile, but passenger trains will go all the way from twelve pounds per car per mile up to twenty or twenty-four pounds per car per mile. The same variations will occur if the hundred ton mile unit is used.

At one time on a line I was connected with the question came up as to why we were consuming so much coal in our freight service; it was shown very clearly that one of the reasons was that the speed of the freight trains was accelerating all the time, while the tonnage was diminishing, and it was shown that if we accelerated our freight trains to the speed of the passenger trains, that we must expect the tonnage of the freight trains to be more nearly like the tonnage of the passenger trains, and the consumption of fuel consequently also more nearly like the consumption of fuel on these high speed passenger trains.

What would this mean on a road like the Burlington road? In July, 1891, the pounds of coal consumed per passenger car mile on the C., B. & Q. was 12.16; in July, 1892, it was 12.08; in freight service in July, 1891, it was 5.12 pounds; in July, 1892, it was 5.55. A saving of one pound of coal per car per mile on the Burlington has been figured as the equivalent of $100,000 a year. If the cost of fuel were increased seven pounds of coal per car per mile, viz., twelve pounds in place of five pounds, it would mean in fuel alone an increase of $700,000 a year. I would strongly advise the railroads to keep the passenger car tonnage separate from their freight car tonnage, and then as freight speeds increase, they will always know the increase they may expect in the fuel bill.

There is another feature about separate passenger and freight mileage that is interesting. It has often puzzled me to know why it was that the wages of enginemen should fluctuate so much per one hundred ton miles. My attention has been called to the fact that the passenger mileage on a road is pretty constant; it does

not vary, it is about the same from one month to another throughout the year, but the freight at certain seasons is very much in excess of the passenger mileage and the freight enginemen's wages being higher than the passenger men's wages, when this freight increases and the figures are all thrown into one, it naturally raises the wages of your enginemen. If you had the passenger separate from the freight, you would find the passenger wage would keep its uniform rate, and the freight wage its uniform rate.

It is early, Mr. Chairman, to propose how this question should be handled, and I am going to make a suggestion which will come more properly at the end of the discussion, and that is, how are we going to get this one hundred ton mileage unit more generally adopted? One way, undoubtedly, is to get it before the managers of the railroads. At the present time the Accountants' Association has a question of how to compute mileage uniformly, before the American Railway Association's committee on statistical information. I will propose that a copy of the February Proceedings of the Western Railway Club be sent to the Railway Accountant Association and also a copy of it to the committee on statistical information of the American Railway Association, and that the Secretary direct their attention to this paper and discussion on ton statistics.

Mr. F. A. Delano (C., B. & Q. R. R.): My friend, Mr. Quereau, asked me to prepare a written discussion on this subject, and I am sorry to say I did not find time to do that, but I read the paper with a great deal of interest and if, in my remarks, I appear to say anything against it I want it understood that it is only in friendly criticism.

To begin with, I must say my ideas are rather confused. It seems to me there are a good many points on which there is good opportunity to differ from the opinions expressed by the writer.

In the first place, he and Mr. Henderson both say that it is useless to get up statistics of comparison of figures made by one road with another, but it seems to me that comparisons will be made until the end of time, and that railways similarly situated ought to be in a position to compare their methods of operating. I cannot see why the cost of handling passengers and freight on the Northwestern main line, and the Rock Island or the C., B. & Q. main line, going through a very similar country, cannot be compared. I do not see why the cost of operation on any of the trunk lines similarly situated cannot

be compared, and one reason why comparisons in the past have been so unsatisfactory is that there has not been a uniformity in the method of accounting and tabulating the statistics.

I once heard somebody say about statistics that they were three kinds of lies,—lies, damned lies and statistics. I think, unfortunately, that that is often the case. The trouble is, statistics are all right if they are made with the object constantly borne in mind of telling us the facts ; they are of no value if they are simply a mass of figures, mixing up "apples and oranges," as somebody once expressed it, and trying to strike an average.

There has been a distinct improvement, in recent years, I think, in railroad statistics, by keeping the branch line mileage and tonnage separate from the main line, and there are other improvements along that line. It seems to me that a few statistics, carefully kept, so that you have got something that you can swear by—for instance, absolutely correct statistics over some one portion of a road, would be of very much more value than the loosely kept statistics over the entire road, where all kinds of figures are jumbled up together to draw your conclusions from.

The *Railroad Gazette*, in an editorial which I read a number of weeks or months ago, spoke of the difference in the methods of computing train mileage in use on different roads. There are some roads that figure construction mileage, pusher mileage, double-header mileage, differently from other roads, and of course when figures are tabulated in such a way you cannot compare the statistics of one road with another.

I am inclined to differ from Mr. Quereau in his opinion about including the weight of the engine with the train. I can see that something is to be said on that side of the argument, but it seems to me that the general manager of a road wants to know what the engine is doing. For instance, suppose the policy has been to get very much heavier engines, he wants to see how much more tonnage those engines are hauling *behind the tender* than the lighter engines did before. If any of us were in the draying business, and were considering the question of the purchase of a pair of Percheron horses or a pair of mules, we would want to know, among other things, how much they could haul ; we would not figure in the tonnage of the Percheron horses and give them credit for that, I do not believe.

I notice an error in the paper, referring to the grade where the

Burlington tests, of which Mr. Quereau speaks, were made. See the bottom of page 4. The grade was, in fact, 1 per cent instead of a half of 1 per cent.

But, returning to this question of including the tonnage of the engine, I am inclined to think that, like a great many other good things, the progress made in the weight of engines has been overdone in a number of cases; that people have been carried away with enthusiasm, or the desire to make a great big machine, and the biggest machine on earth, and all that sort of thing. There are a great many cases and a great many kinds of service where the lighter engines will do the work more economically, and you are likely to get the wrong impression by including the tonnage of engines in your statistics. What we want to know is what the engine is pulling, not what the steam is doing in the cylinder. That is another and separate question.

Now, as to how tonnage should be determined. Is this tonnage system used in order to give more accurate statistics? If so, it seems to me we want to have the tonnage of the train when loaded or empty, the actual tonnage hauled. We do not want to add an arbitrary figure such as Mr. Quereau suggests. I understand the Pennsylvania Lines west of Pittsburg, have the practice of adding seven tons for every empty car. I do not know what they add to a partly empty car. If they add seven tons for an empty car, they ought to add three or four tons to a car lightly loaded, like a car of merchandise! Suppose an officer of that road tells me that his engines are pulling 2,000 tons. I take it as gospel truth, but in looking into the matter find that it is *paper* tonnage. It seems to me that that kind of statistics is a great deal like those I referred to a moment ago.

Now, there is another thing that tonnage may be used for, and that is in rating trains. I was on the committee which introduced the tonnage rating of engines on the Burlington road, and in watching the operation of it I came to the conclusion, and I think every one has come to the conclusion that, considering that it involves a more laborious way of determining the number of cars to put into a train, it is not *worth the candle* on a level grade line. I think when it comes right down to it, that, on a level line with no grades, the old method of rating by loaded cars and empty cars is quite as satisfactory a method, and quite as accurate a method of determining what an engine can pull as the tonnage rating method. Mr. Quereau says you

have got to make an allowance of 56 per cent in excess for empty cars on a level, and, as I have suggested before, he does not say what allowance should be made for partly empty cars, and most roads, whether they make an allowance in this way or not, put a limit on the length of trains of empty cars. That is to say, if an engine will haul 1,500 tons of loaded cars, they limit the length of train to 65 and 70 empty cars, or say 1,050 tons. I think it is natural to expect that the tonnage will not be an accurate measure of work with empty cars on level roads. We know that when the grade resistance is entirely eliminated, the other factors of train resistance vary a great deal more with different cars than they do with the lading, and after quite an extended experience with operating a "poling" track in a switch yard, I concluded that *some* heavily loaded cars would run more easily down the grade (the grade used was one-half of 1 per cent) than some empty cars, or, in other words, a badly constructed or badly designed empty car would stop on that grade, when a loaded car with good journals and good side bearings, etc., would run easily.

Mr. Rhodes: I want to thank Mr. Henderson for a suggestion that I have gained this afternoon, which I am going to investigate when I go west again. On our line we have been bothered quite a little with the inequality of our oil records, especially on engines. We have one division which is composed principally of light 4-wheeled connected engines, and the cost per 1,000 miles for oil on those engines is about $1.30 to $1.40. What the cost per one hundred ton haul is, I do not know.

On another division the cost is up as high as $2.50 per 1,000 miles. But what is the difference? This division is equipped with heavy 10-wheel engines, all hauling big tonnage, and from what Mr. Henderson says, it may be that if we were to change our basis of computation, get our unit a little more uniform, perhaps we will find that some of these high figures are incident to an improper unit, and not to any improper work on the road.

Mr. Delano: I want to ask Mr. Quereau one question. It is not his idea, is it, that the empty and loaded car statistics should be dropped?

Mr. Quereau: I would say that, of course, would be determined by the management of the road. But in this connection I think it would be well to call attention to the fact that the statistics which are kept on the car mile basis, or the mile basis, must be kept for one

year after the ton mile basis is in use, in order to afford a basis of comparison and bridge over the period made necessary by starting in on the ton mile basis. If it is desirable to keep it after that, well and good, but it should be done if you want to keep a continuous comparison of your record. I was instrumental in introducing the ton mile statistics on the B. & M., in 1896, I think it was; during the year 1896 we kept our engine statistics on the engine mile basis as well as the ton mile basis. That afforded us a chance for a comparison and no break.

Mr. A. W. Gibbs, assistant mechanical engineer, Pennsylvania Railroad, subsequently presented the following written discussion of the paper:

ALTOONA, PA., March 1, 1900.

Mr. Jos. W. Taylor, Secretary W. R. R. Club.

DEAR SIR:—I have read over very carefully Mr. Quereau's letter on tonnage statistics, and think that the difficulties of basing statistics on the ton mile are very great, for the reasons given by him in his letter.

The elements to be considered as a basis for tonnage statistics will depend altogether on the objects for which they are to be used; that is, where it is a revenue question, only paying load should be considered, while for the information of the operating head, both cars and loading should be considered, while for the purpose of making up trains, the engine and tender may have to be considered, in addition to that of the cars and lading, although this is rather doubtful.

Similarly with a system of adjusted tonnage, which consists of adding to each car an arbitrary number of tons so as to compensate for the empty and loaded cars, this rating varying on different divisions. This is merely a method by which the yard master is able to equalize in his train loading, cars of widely different classes, and for this purpose it is thoroughly satisfactory.

The total figure for this adjusted tonnage is not, however, the actual one, nor is it properly used in making up tonnage statistics; in other words, it is satisfactory only for the particular purpose of equalizing train weights.

The resistance per ton of the heaviest class of loaded coal cars is, on straight and level track in summer weather, sometimes as low as 2.2 pounds, and for coal cars carrying 60,000 pounds, as low as 2.9 pounds, while for the same cars empty, each car then weighing 12.1 tons, the resistance under the same circumstances will be as high as 6.7 pounds.

This ratio between the most heavily loaded coal cars and empty cars is about three to one on the level, but the difference rapidly disappears when the constant addition is made for grade and curve resistance.

Finally, I think that when so many variables affect the question of tonnage, mileage statistics based on them and used as a basis for comparison, are about as misleading as those based on the car mile or any other unit, and even on the same division where the heavy tonnage is in one class of service, the comparisons be-

tween the engines hauling that class of tonnage and others hauling lighter classes require considerable explanation before fair comparisons can be drawn.

Yours very truly,
A. W. Gibbs,
Asst. Mechanical Engineer.

Mr. Quereau: I am a little disappointed that there is no more discussion on the subject. There are one or two points I want to call attention to. One is next to the bottom paragraph on page 2, speaking of the weight of the train to be included in the ton mile statistics. And, by the way, a distinction should be made. This paper does not refer to tonnage rating; it refers to ton mile statistics. In tonnage rating I do not see anything to be gained in including the engine and the way car, but in ton mile statistics, which should be a measure of the work done by the locomotive, I can see no good reason, even in spite of the arguments which have been advanced this afternoon, why these should not be included.

For instance, the argument has been presented that the management is interested in knowing what certain heavy engines are pulling behind them; they can easily determine that, and the fact that the way car is included in the ton mile will not prevent the larger engines from making a better showing and showing that they pull more tonnage. In fact, if anything, it will slightly exaggerate. With modern designs the weight of the train behind the engine will be increased in weight in proportion to the weight of the engine itself, because I do not think there is anybody designing an engine today who would not give it all the cylinder power which is warranted by the weight on the driver. So that including the way car in no way varies the result as to what the larger engines are doing.

In that connection the paragraph to which I first called attention contains a statement, in speaking of the same subject, which seems to me worthy of explaining:

"Nor do I believe that a progressive general manager would disagree with these conclusions, if properly presented, or fail to realize the importance of economical methods in managing this department and the necessity of accurate statistics to accomplish this end." And in another paragraph of the paper, I cannot turn my eye on it now, I claim that, instead of assuming that we should do so and so because the general manager (and by general manager I mean the management) wished to make comparisons with different roads, or wished to

do this or do that, I make the suggestion that the logical thing to do is to inform the general manager that such and such a comparison is not a wise one and that reasonable conclusions cannot be made by such comparison. I realize the fact that the managers of the roads have not the time to go into the details, the whys and wherefores as to making the statistics, why they are made in this way and that way. The manager simply takes them from the operating officials and those presented to him by the operating officials of other roads. He has not time to see whether the basis is a correct one or not. Under the circumstances, it seems to me the logical thing is to present the matter in the true light, at least the true light as it appears to us, concerning the reasonableness of the comparison and correctness of the basis of the statistics, or what is to be obtained by making these comparisons.

One of the speakers said that he did not quite see how the ton mile basis was applicable to work trains. I will say, in reply, that that system of basing work train statistics on the ton mile has been in operation since 1896 on one road. He says, Yes, you can do that, but what is the good of it? My reply is, What is the good of giving an arbitrary ten miles an hour to a work engine as a credit against which to charge coal? In this regard it seems to me much more logical and reasonable to give an engine credit for the ton mileage that actually belongs to it; it takes out so many tons in the train and travels so many miles. The product of the tons and miles gives the ton miles.

The chief point in that, however, is to put all the statistics of the motive power department, so far as engine performance is concerned, and costs, on the same basis. The same thing applies to the switch engine. The main object in doing that is to keep all the motive power statistics on the one basis of costs per ton mile for supplies and for wages.

Mr. Deems: I want to say a word in self-defense. My friend Quereau says that I said "What is the good of the work train ton mile basis?" I suppose he misunderstood me. What I did say was, "How do you do it?" What I want to know is, whether they use an arbitrary mileage basis or not. That is the idea.

Mr. Quereau: No; if a train traveled ten miles, and has 100 tons, obtain the product, (that gives the ton mileage,) as you would any ordinary train on the road.

PRESIDENT HETZLER: If there is nothing further, I will ask Mr. Rhodes to offer his resolution.

MR. RHODES: I would move you that the Secretary of this Association be instructed to send a copy of these proceedings to the secretary of the Association of Railway Accounting officers, and also to the American Railway Association's committee on statistical information. (Seconded.) If it is sent to Mr. Allen it will reach the committee.

PRESIDENT HETZLER: Remarks are in order. All in favor of the motion as made, please manifest it by saying aye. (Carried.)

RECESS.

President Hetzler: We will now proceed to discuss Mr. Stark's paper, which I will ask him to review.

Suggestions for Revision of the M. C. B. Rules for Loading Long Material.

By F. H. Stark

M. C. B.—C., L. & W. Ry. Co.

In presenting the subject assigned to me, relative to the Master Car Builders' Association, recommended practice, governing the loading of open cars, my investigation of the subject has confirmed my first impulse, that is, that there is little room for changes in the present recommended practice. There might be, however, some additions to cover the loading of material not now provided for in the present rules. Being located in a section where there is not much extra long timber handled, I am not in a position to intelligently make any criticisms or recommend any changes, but simply raise a few points for your consideration.

Taking up the rules as published by the Master Car Builders' Association, we find by referring to them that the cuts indicating the manner in which long timber shall be loaded, Figs. 1 to 8 inclusive, would indicate that the timber should be loaded on its broad side. Figs. 1 to 3 inclusive, cover comparatively short timber, and I believe it is found in practice to meet the requirements. Figs. 4 to 8 inclusive, if timber is loaded on its broad side, with bearings spaced as per instructions, will not remain clear of the car floor, though the present rules prescribe that the load must clear. To accomplish this, it would require very deep floor bearings. Long 70 ft. sills when loaded as per Fig. 7, bearing bolsters 50 ft. centers, with floor bearings of dimensions commonly used with timber loaded on the broad side, will deflect at the center as follows. This is based on a test made of Southern pine of only one piece of timber under statical conditions:

Timbers 4 in. x 8-in., varied from 8 to 9½ inches at center.

Timbers 4½ x 8-in., varied from 4 in. to 6 inches at center.

Timbers 5 x 14-in., varied from 5 to 6 inches at center.

The deflections under same conditions with timbers set on edge are as follows:

Timbers 4 x 8-in., deflection 3 inches.

Timbers 4½ x 8-in., deflection 2½ inches.

Timbers 5 x 14 inches, deflection 1 inch.

The query suggests itself, ought the rules prescribe that long timber not less than 4 inches thick be loaded on its edge? To load timbers of extremely long lengths on their broad side, according to present rules, would necessitate floor bearings of such depth in order to maintain the load clear of the car floor, that would render it liable to cause the bolster floor bearings to roll or turn over, and I believe that the experience in practice is that the bolsters generally used are not more than 10 or 12 inches deep, and the load bears more or less on the car floor. Timbers less than 4 inches thick, if loaded on edge, would require additional clamping to make the load safe. Inasmuch as there is quite a good deal of very long timber, such as timber for passenger cars, ship plank, etc., would it not be well to pro-

vide some other method of loading ? It has been found through experience that long flexible plates, T rails, etc., are safely transported on two cars with more than two bearings, and I would submit for consideration the feasibility and practicability of loading long timbers of limited thickness on four bearings, similar to the method of loading long T rails, except that the difference in height between the two inner bearings and two outer bearings be greater (see cuts 4 A. to 7 A. inclu-

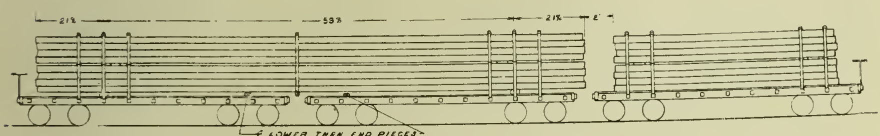


Fig 4 A

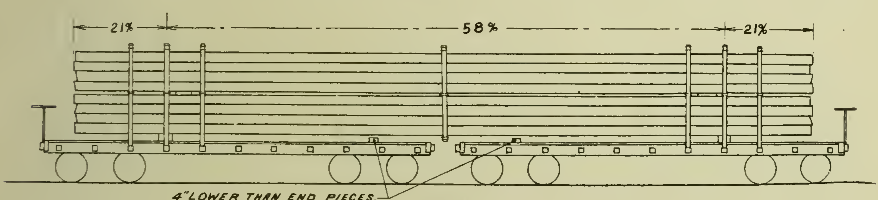


Fig. 5 A.

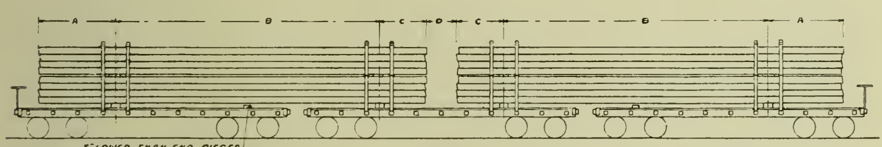


Fig 6 A

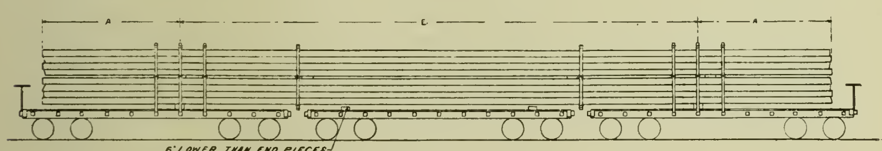


Fig 7 A

sive), and to be governed somewhat by the length of timber loaded. The greatest difficulty in this regard would be lack of suitable material for clamping or securing the load. The two inner floor bearings should be of hard wood, preferably with the top surface dressed and well greased before the load is placed on the cars. The center of the load should be held intact by the application of wire across the load, or some other practical method. The foregoing are simply suggestions and not recommended changes.

LOADING LOGS, PIPE, STONE, ETC,

Under the head of "loading long logs, pipe, stone, etc.," as found on pages 11 and 12 of the M. C. B. recommended practice, I would recommend that there be added more extended rules for loading stone and the addition of rules governing the

loading of cross ties, fence posts, dressed lumber, etc. The paragraph governing the loading of stone, now contained in the rules, I would recommend be canceled, and substitute more general rules, and, as a matter of convenience, will refer to them as paragraphs A, B and C.

Paragraph A. Flat cars loaded with grindstones, flagging, large breakwater or block stone, resting on approximately straight face shall be provided with substantial hardwood end stakes.

Paragraph B. Flat cars loaded with curbing, or large block or breakwater stone, resting on uneven surface, shall be provided with substantial hardwood side and end stakes.

Paragraph C. Flat cars loaded with paving stone, riprap, spauls, or other stone of such dimensions as are not safe to be loaded as per paragraph B, shall be provided with temporary side and end boards.

CROSS TIES AND FENCE POSTS.

Cross ties or fence posts loaded in gondola cars with not less than 48-inch sides, may be loaded on ends if loaded compactly. Cars with sides less than 48 inches high, shall be loaded lengthwise, or crosswise of the car. If loaded crosswise, the load must not extend above the car sides. If loaded lengthwise of the car, load must not stand above the sides (unless supported by two pair of side stakes to each tier, properly tied at top) but may be loaded higher at center of load, the entire length of car, secured with four strands of No. 8 wire, drawn taut at each end of each tier of timbers. Flat cars loaded with cross ties or fence posts must be loaded lengthwise; one piece shall be located crosswise of the car at each end, inside and adjacent to two end or side stakes. One tier shall be loaded on each end of the car lengthwise in an inclined position, outer end being elevated, and balance of the car loaded lengthwise, with as many tiers as the length of the car will permit. Each tier shall be provided with two pair of side stakes to each tier, tied across the top as per general instructions No. 7.

It has been the practice to load cross ties and fence posts crosswise on flat cars, but it is generally considered unsafe practice, on account of the liability of pieces of timber shifting to one or both sides, exceeding the limit of clearance; this is especially true during winter months.

The recommended practice governing the loading of structural material, plates, rails, etc.; by referring to the next to the last paragraph of Rule 6, it will be noted that single flat cars must not be used for rails, bar iron, etc., unless provided with substantial end boards to prevent the load from shifting. Flat cars used in such service are usually provided with 12-inch end plank, to load the car to the limit; the load often exceeds the height of end plank. This is also true with many low side gondola cars. Most roads are accepting and running cars in this condition with no serious results. Any road requiring that end plank shall equal the height of load, I believe should provide it at their own expense. If railroads do not provide proper equipment, surely the shipper should not bear the burden of cost involved in providing additional temporary end plank.

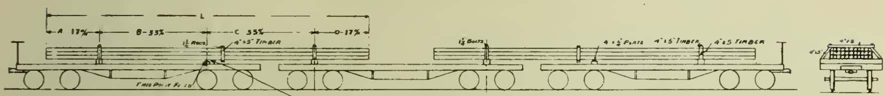
DRESSED LUMBER.

Dressed lumber should always be loaded into box or stock cars. Flat cars should not be loaded with dressed lumber, except by permission.

RAILS.

On account of the increased shipments of 45 and 50-ft. T rails, I would sub mit for consideration the addition of another cut, to be designated as Fig. 12 C.

MANNER OF LOADING 45 TO 50 TEE AND GIRDER RAILS.



RAILS 6" OR MORE - 2" LOWER
RAILS LESS THAN 6" - 4" LOWER

Fig 12 C.

We have handled quite a good deal of 45-ft. rails loaded in this manner, the Lake Shore and Pennsylvania Companies approving of the method of loading to 75 per cent of the marked capacity.

SPACING BLOCKS.

I would also beg leave to call attention to the matter of spacing blocks between double loads of timber as shown in Figs. 10 to 13 inclusive, for rules governing the loading of long timber, and Figs. 18 to 21 covering the spacing blocks between twin loads of structural iron, T rails, etc. Since it is only a matter of a short time when all cars will be provided with M. C. B. couplers, the necessity for spacing blocks will be largely obviated. Figs. 13 and 21, show manner of providing spacing blocks where both cars are equipped with M. C. B. couplers; these blocks are so small that they amount to little or nothing. I believe that all cars equipped with good substantial draft attachments and M. C. B. couplers, with M. C. B. coupler yoke (or pocket), that it is perfectly safe to handle twin loads without any blocks whatever to take up the slack. The effect on the load itself is not serious. The shifting or displacement of load where both cars are equipped with M. C. B. couplers has proven in practice to be a matter not worthy of much consideration. The load carried on the floor bearings, very materially cushions the blow or strain caused by stopping or starting the cars. I agree that in some cases where there is an exceptional amount of slack in the draft attachments, it is desirable to take out the slack. This should be decided by each road for itself, and they provide the material and labor, or, in other words, the receiving road should equip the cars whenever they deem it necessary.

SAFETY CHAINS.

We believe we ought to create a sentiment in favor of equipping all flat and gondola cars with permanent M. C. B. standard safety chains. Shipment of long material is increasing every year. The first cost and loss of car chains is quite an item, together with cost of applying the chains to twin loads. The danger involved in moving cars chained up should be considered; the chains hang loosely, and should the cars uncouple, the chances are the chain would give way. Then, too, the chains are liable to become detached and drag on the track, causing damage to switch points, if not derailing the cars. I would include gondola cars, for the reason that flat car equipment in proportion to other classes of rolling stock is growing less, hence, gondola cars are pressed into similar service. Permanent safety chains would aid in pulling cars off of very sharp curves where the M. C. B.

couplers will not couple, for it is this class of equipment that frequents mill yards, etc.

I trust this whole subject will be freely and fully discussed.

Mr. F. H. Stark (C. L. & W. Ry.): I believe everybody has had a copy of this circular, and as the hour is late, if I may be allowed, I will simply refer to the circular, taking up the question of loading open cars, and especially on the first topic,—loading long timber.

I approach it with a great deal of reluctance, for the reason that I am on the committee on loading long timbers and have been for last three years, and I never have introduced anything new or suggested anything with reference to loading long timber, for the reason that very little of this is handled in the locality where I am located. I was prompted, however, in raising this question, from two communications received from chief joint inspectors located at two very extensive interchange points. They advised me that almost invariably where twin loads of long timber passed through their inspection point, that the center of the load rested heavily on the car floor. It is true that the rules prescribe that there should be a clearance of four inches. It is common practice, however, to use about 10 x 10-inch bolsters, and with bolsters of these dimensions the timber will deflect at the center considerably. Add to this the sag of the car, and the loads are apt to rest on the car floor. I inquired of two of our prominent car building concerns and asked if there was any damage to the timber by reason of its resting on the car floor. They said there was not much damage done in this way, although they admit that timber does rest more or less on the car floor and of course retards the free curving of the cars.

My prime object in bringing up the question of loading the long timber was with a view of bringing out by discussion here the experience of those who handle this class of freight, as to whether it is not possible to load the cars to their marked capacity. According to present rules, there is an arbitrary load fixed which is about two-thirds of the marked capacity.

When our steel mills first commenced to manufacture 60-foot T and girder rails, the railroads running out of Pittsburg attempted to load these rails on one bearing to each car. This was found almost

impossible, as it would require floor bearings very high indeed to maintain clearance between the load and the floor. Some five or six years ago they commenced rolling steel rails at Lorain, and we found it was impossible to load twin loads according to the old standard rules of the Pennsylvania company, the Lake Shore and other companies.

In the meantime, the roads running out of Pittsburg introduced the third bearing, two bearings on one car and one bearing on the other. This, of course, was an uneven distribution of the load, and the third, or middle bearing, being located between the body bolster and the end sill, had the effect of breaking down the end of the car when the car passed over a railroad crossing where there was an elevation and a sudden decline on the other side. We then introduced at Lorain four bearings, two bearings on each car, and we sent out a drawing to a number of the trunk lines and asked their permission to allow us to ship twin loads loaded in this manner. They agree to make a trial shipment at least, and it was found to work very satisfactorily, and since that time we have made it the practice, according to the M. C. B. recommended practice today, to load T and girder rails to the full marked capacity of the cars.

I appreciate the fact that at saw mills railroad companies, as a rule, have no inspectors to see that the load is properly secured. It is also true that they have not got the proper material for clamping the load, but if this feature of it could be worked out in a practical way, it would be a decided advantage to the railroad company if they could load the full marked capacity of the car rather than 75 per cent.

Then, too, I find that in loading twin loads, with one bearing on each car, that it is very destructive on the car body, or longitudinal sills, and I believe that with the four bearings, with the proper allowance made for deflection at the center, making the two inner bearings somewhat lower than the outer bearings, that neither of the trucks would be overloaded, and by clamping the loads securely in the center, that the load will be maintained in position, or, rather, it will be kept compactly and there will be no trouble experienced.

In regard to loading logs, pipes, stone, etc., the present rules do not give any instructions with reference to loading stone, in particular. You will note, that I have suggested some additions to the rules governing the loading of stone. I think this is very essential, as the stone is very frequently shipped long distances, and where each com-

pany have rules of their own, such shipments are liable to be held up at interchange points.

In regard to the loading of cross ties and fence posts, there is nothing whatever in the rules referring to shipments of this character. From my own observation, I believe it is a poor practice to load cross ties crosswise on a flat car. In winter weather the ties will shift one or both ways, so that it will not clear permanent structures, and this makes it very dangerous, especially on a double track road.

The rules do not give any instructions relative to the loading of dressed lumber. It sometimes occurs that mills, when there is a shortage of cars, load dressed lumber on flat cars. I think this ought to be prohibited, and the lumber loaded either in stock cars or box cars.

There are a great many rails being turned out now, forty-five feet long, and there is no provision in the rules for the loading. We found it necessary to take this up with two or three of the trunk lines, and submitted a plan for loading 45-foot rails. This plan was accepted by the Pennsylvania and Lake Shore, and we have made shipments of this length of rail for some time past which have been very satisfactory.

I believe that a new cut should be inserted in our rules, showing the manner of loading 45-foot rails.

In regard to the spacing blocks between twin loads, we all realize that the time is near at hand when all cars will be equipped with M. C. B. couplers, and the practice of applying a small oak block between the buffer horn of the coupler and the end sill or head block is of little value. These blocks are applied at the mills where the shipment originates, and before the cars get out of the mill yard these little blocks are usually simply crushed; the face of the head blocks or end sill is more or less damaged by the force of the coupler horn, and, hence, the block offers but very little resistance. I would be in favor of omitting the rule prescribing that this block should be applied. I believe that where both cars are equipped with automatic couplers, and good rear attachments, that double loads can be safely handled without any spacing blocks; the load itself resting on the floor bearings cushions the blow or strain, and the result from a little slack is worthy of very little consideration.

One other point which, perhaps, is not altogether in keeping with the subject, and that is the equipping of open cars with permanent

safety chains. We find at Lorain, where a great deal of this traffic is offered the Nickel Plate, that they have to keep two men there to apply car chains, and they find it difficult sometimes to get their chains returned. Besides this, they frequently allow the cars to go off the line with these chains, and there is more or less loss of chains, and it would be a great saving in labor, beside other advantages, in having all open cars equipped.

When I was at Cleveland, recently, the chief joint inspector told me that there were more double loads loaded on gondolas at Cleveland than there were loaded on flat cars; hence it would appear as though it were necessary to equip gondolas as well as flat cars.

This subject is one that the men in charge of interchange are especially interested in, and I am sorry that so many of the members have found it necessary to retire, yet I hope the matter will be freely discussed.

Mr. P. H. Peck (C. & W. I. R. R.): I find in our interchange, not so much trouble with the common structural material or with T rails, but we do have a good deal of trouble with piling and long poles—they call them poles—they are forty-five to fifty feet long and thirty inches in diameter. Most of the trouble originates from improper loading in the first place. I have taken the question up with several of the roads in cities, and I find that the mechanical department, or car department, has nothing to do with loading of this material in the timber country where it comes from. The transportation department does that, and in a place where there are two or three lines competing, they permit the shippers to lead them any way, and I have been told by master car builders that they have known of some cars being transferred three times before they reached Chicago.

As far as chains are concerned, some roads handle this matter differently from others. On some roads the car department returns the chains and handles them completely. On other roads the car department has nothing to do with the chains on the car at all. We had so much loss and trouble in our service that I instructed our connections to remove the chains before giving them to us. We never had but two cars uncouple on our road, and on both occasions the chains broke, uncoupled or unhooked. If the piles and piling were loaded with more care, the same as they do with construction material, we would have no trouble whatever. I do not know that

we have ever refused a load of construction material, but we have refused hundreds of loads of piles.

I understand some of the roads running west out of the city haul the cars as far as Denver without change. I would like to know if that is a fact.

President Hetzler: I will ask Mr. Quereau to answer that question.

Mr. Quereau: This is a matter in which we are not especially interested on the Denver & Rio Grande, as we have very little material of this kind either to load or to receive from other roads and for that reason I have given the subject almost no attention. I do not feel competent to say anything on this subject.

Mr. E. E. Russell Tratman (*Engineering News*): I see Mr. Stark mentions only rails forty-five to fifty feet long. I should judge the tonnage in sixty foot rails, especially street or girder rails, is very much heavier, and these rails would require quite a different loading arranged in cut from that shown on the diagram.

Mr. Stark: It is already given in the rules; they show how sixty and sixty-five foot rails could be loaded.

Mr. C. R. Tunks (L. S. & M. S. R. R.): I have noted with interest the subject presented by Mr. Stark, — suggestions for revision of M. C. B. rules for loading long material—and in connection with them would call attention to one present feature in force, namely: The application of three stakes to each carrying car as per Figs. 4 and 5, without limitation as to distance from each other, the rule simply stating they must be placed as near together as possible in each carrying load. I have noticed several times such lading with one or more stakes broken on each side of each carrying car, due to excessive distance between the stake pockets, (in some instances nearly five feet,) while passing over sharp curves in transit.

In my judgment these conditions are conducive to derailments, also wheels becoming loose on the axle by severe impingement with the rails; the breaking of the stakes owing to unlimited distance permissible of the stakes is the usual result, and wheels have been found loose, also, unquestionably due to the same cause.

Mr. Stark's advocacy of equipping both flat and gondola cars with safety chains, is, in my judgment, the safest and most economical appliance as a factor in transporting, safely, long material loaded on two or more cars.

Mr. Rhodes: I have been quite interested in this report of Mr. Stark's, although I have not given it the attention that the report deserves, but I propose doing so later.

It seems to me that this is a matter that can very well be taken up with the supply departments of the different railroads. Perhaps master mechanics do not have enough of the loading to do to get much interested in a subject of this kind.

On our line we have a central distributing point where we do a great deal of loading, and it is my intention to take this paper up with our supply agent and his loading foreman, and see whether we cannot conform to the recommendations made by Mr. Stark.

There is one criticism that I would make. I was going to interrupt Mr. Stark and ask him how this loading described on page 4 was accomplished; how the trucks were got under the two cars, but fortunately I did not expose myself. By a little more careful examination, I see there are three cars there, and I would suggest that the cuts be made a little plainer, which may be easily accomplished by representing the three cars without hose connection between, as is done in cuts Fig. 6A and Fig. 7A on page 2 of this pamphlet.

Mr. Stark, on the third page of his paper, speaks about the danger of loading ties in cars, crosswise of the car in place of lengthwise. Last week, when I was in South Dakota, I noticed an instance of the danger from that very thing. The ties in the bottom of the car had been laid lengthwise, and then to avoid putting stakes up, those above had been put crosswise; something had shifted the load and the ties projected on the top some two or three feet beyond the regular width of the car which, as Mr. Stark says, is a dangerous proposition on a double track road, and not a safe one on a single track road.

Mr. R. D. Smith (C., B. & Q. R. R.): I have read this paper with considerable interest, and would say that I believe this subject to be one that is almost entirely dependent upon local conditions. While it is true that it is governed, to some extent, by the road upon which the load originates, I think that the remedy lies with the receiving road; i. e., it is the duty of the road receiving the car to make such changes as are deemed necessary, in order that the load may be safely handled. I would, therefore, question some of the recommendations that Mr. Stark has made.

He recommends that long sills and similar pieces be loaded on edge; this would require, as he says, more care in fastening, and

I seriously doubt that there would be sufficient improvement to compensate.

The addition of two center bearings, as recommended on page 2, for long timbers, appears to me to be of small practical utility and considerable extra expense. If twin loads are properly put on the cars, I do not think that there will be enough sag to warrant the increased expenditure for center bearings.

For transporting cross ties and fence posts, I consider the use of box or stock cars to be the safest and best method. As time is not generally an important factor with this class of freight, it can be held until there are empties going in the desired direction.

With reference to discontinuing the use of spacing blocks, I cannot agree with Mr. Stark, even for cars fitted with M. C. B. couplers. It was the practice to place a wedge between the two drawbar heads when the link and pin coupler was used, and thus take up the slack. This cannot be done with the M. C. B. coupler, but the slack in the rear end attachments can, and should, in my opinion, be taken up by spacing blocks.

In regard to the use of safety chains, I believe that they are of value where twin loads are handled, and if the business is extensive it would be economical to equip the cars with permanent safety chains. On the Burlington, however, there has been a rule in force for several years against the use of chains on twin loads, and I do not believe it has caused any extra expenditure on account of shifting loads, etc., while there has undoubtedly been a great saving in chains.

There is one point in connection with twin loads which I think is worthy of notice, and that is on such loads I think we ought to disconnect the uncoupling devices on M. C. B. couplers, and fasten down the locks wherever they are of such a pattern that they tend to crawl.

Mr. Stark: I would like to make one correction. Mr. Smith referred to a recommendation here with reference to loading long timber. If he will notice, in the lower part of page 2 it says, "the foregoing are simply suggestions, and not recommended changes."

I believe, however, on giving the matter more thought, that it is worthy of consideration. He speaks of the two inner bearings being of little value. If we can increase the loading and carrying capacity 25 per cent, I think it is of considerable value, and inasmuch as we can load successfully T and girder rails to the full marked capacity

on the four bearings, I see no reason why we cannot load long timber in the same manner, except that we have not got the same facilities for clamping the load in the center, even though we should continue to load 75 per cent of the marked capacity. The two inner bearings are quite essential. To load 75 per cent of the marked capacity on one bearing on each car is the worst test that we can give the car, and I find that on cars loaded that way, very frequently the sills are fractured.

In regard to the spacing blocks, referring to the old custom of driving a wedge in between the coupling link and the coupler head, this amounted to about as much as these little blocks that we put in back of the buffer horn. The first time the slack of the train runs up it smashes the block. The roads that run out of the Pittsburg and Lorain districts, where they handle so many of these double loads, have about come to the conclusion that these little blocks do not amount to anything.

Mr. R. D. Smith: I certainly did not express my ideas correctly, if I said that the extra center bearings would be of no value, and I desire to make a correction. What I do wish to say is that I do not think there is sufficient necessity for center bearings, in the majority of cases, to justify the increased cost. They require to be planed or lined with iron, lubricated, and otherwise carefully constructed, in order to perform their function without shifting the load, and I think we can get along without their use.

In reference to what Mr. Stark has just said concerning the loading of cars, the trouble is usually caused by not placing the crosspieces properly. There is but little danger of breaking a car if the cross piece is put up over the needle beam instead of in the center. If the length of the load prevents placing the cross piece over the needle beam it should be placed as near to that position as possible.

President Hetzler: If there is no further discussion, it is in order to adjourn.

Adjourned.

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1899—May.

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1891,	January	24	"
	February	11	"
	March	12	"
	April	20	"
	May	26	"
1892,	April	32	"
	September	15	"
	November	17	"
	December	10	"
1893,	January	29	"
	February	3	"
	March	10	"
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	May	15	"
	September	5	"
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	March	98	
	April	1	'
	May	1	
	September	12	
	October	4	
	November	12	'
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	March	1	"
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	November	39	"
	December	188	"
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	April	8	"
	May	181	
	September	165	"
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	February	128	"
	March	47	"
	April	32	"
	May	12	"
	Total	2,096	

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

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THE regular monthly meeting of the Western Railway Club was called to order at 2 p. m., Tuesday, March 20, 1900, in the Auditorium Hotel, Chicago. President H. G. Hetzler in the chair.

The following are the names of those who registered :

Baldwin, W. H.
Ball, H. F.
Barber, J. C.
Bischoff, G. A.
Blanchard, W. A.
Brazier, F. O.
Cardwell, J. R.
Clark, F. H.
Cockfield, Jos.
Coffin, G. B.
Cooke, W. J.
Crosman, Walter D.
Cosper, W. P.
Crane, Chas. A.
Cushing, Geo. W.
Dean, Nat. C.
Deems, J. F.
Delano, F. A.
DeRemer, W. L.
Elliott, W. H.
Farmer, G. W.
Feldman, A. M.
Forsyth, A.
Forsyth, W.
Gardner, J. W.
Goehrs, W. H.
Golder, L. W.
Grafstrom, Edw.
Groobey, Geo.
Hawkins, C. W.
Hayden, R. C.
Henry, C. S.
Hetzler, H. G.
Hill, Jas. W.
Hogan, S.
Hone, A. C.
Hubbell, Ira C.
Hunt, Thos. B,
Jackson, E. J.
Jacoby, W. L.
Keeler, Sanford
Kerr, Prof. C. V.
Kirby, T. B.
Lingo, John
Mackenzie, John
McAlpine, A. R.
Medway, John
Melcher, Chas. W.
Mileham, C. M.
Miller, Wm.
Morris, A. D.
Nichols, G. P.
Parish, L. G.
Paxton, Thos.
Perry, A. R.
Raidler, W. P.
Sanborn, J. N.
Sargent, F. W.
Smith, R. D.
Smith, W. A.
Soule, R. H.
Spear, F. R.
Sprague, W. T.
Stark, F. H.
Stocks, W. H.
Taylor, J. W.
Tratman, E. E. Russell
Ward, M. E.
Wheeler, J. T.
Wheeler, Wm. B.
Whitridge, J. C.
Wickersham, R. S.
Wickhorst, W. H.
Wolgemuth, L. E.
Woods, E. C.
Woods, J. L.
Yeomans, G. G.
Zeleny, Frank

President Hetzler: The minutes of our last meeting will stand approved, as published, if there are no corrections.

The Secretary will read the names of new members accepted by the Board of Directors this morning.

The Secretary then read the following:

Edw. Grafstrom, M. E., Ill. Cent. R. R., Chicago.
Fred. S. Harris, Asst. Supt., First Div. D. & R. G. R. R., Denver.
A. T. Cota, Air Brake Instructor, C., B. & Q. R. R., Aurora.
C. W. Dieman, Mach. Shop Foreman, G. B. & W. R. R., Green Bay, Wis.
L. N. Hopkins, Supply Agent, C., B. & Q. R. R., Chicago.

President Hetzler: Next in order is new business. If there is no new business, I wish to announce that at the April meeting of the Club, the report of the committee on Revision of Rules of Interchange will be presented and discussed, in order that a report may be made to the arbitration committee of the Master Car Builders' Association. Also, the committee on Smoke Nuisance will report at that meeting. The paper to be presented and discussed is entitled, "Improved method of handling materials through shops and storehouses," by J. M. Taylor, storekeeper, Illinois Central R. R. Co.

We will now take up one of the papers of the day, namely, "Purchasing under specifications," by Mr. Ira C. Hubbell. I will ask Mr. Hubbell to read his paper, and make such remarks as he desires.

Mr. Ira C. Hubbell (K. C. P. & G. R. R.): It is said that Bill Nye's bump of caution was well developed. Bill was scheduled to deliver a lecture in a certain town, and arriving there in the morning, he thought it was the part of good judgment to sample the egg market. He found that eggs were worth eight cents a dozen, and that good eggs were worth eighteen cents. Later in the afternoon Bill discovered that there had been more of the eight-cent eggs sold that day than of the eighteen-cent eggs, and he did not deliver his address.

Purchasing Under Specifications

By Ira C. Hubbell

Purchasing Agent, K. C. P. & G. R. R. Co.

In a paper read before the New York Railroad Club by a well known gentleman, a precedent was established that permits your speaker to make quotations from that book so generally accepted as *the* book of books:

"Wisdom is the principal thing; therefore, get wisdom; and with all thy getting, get understanding." (Prov. 4-7.)

"Happy is the man that findeth wisdom, and the man that getteth understanding." (Prov. 3-13.)

Friction between individuals results always from a false estimate of our individual importance.

The organization necessary to operate a railroad brings together a large number of persons, each possessing varied capacities, and the best results follow where the several talents are fitted into each other, as the wheels of the clock, each doing his best for the best result of the whole, and each realizing the usefulness of the others.

The departmental lines should never be so rigidly drawn as to occasion a decrease in the net results of the railroad's operation; and it particularly devolves upon the one to whom is assigned the purchasing of the varied lines of materials required in operating and maintaining a railroad, that he shall adapt himself to the entire railroad and become a part of all departments, show no partiality to any, and belong wholly to no one branch of the service.

The heads of each department should consider the purchaser as a part of that particular department, and the two, with the other officials, work for the sole object of an increase in the sum to be placed to the credit of profit and loss account at the end of the year.

"What is worth doing at all, is worth doing well" presents to your ears words familiar to you from your childhood days.

There may be several ways of accomplishing this "well doing." "Two heads are better than one," is also as familiar to you as "two times two are four;" nevertheless, there are both wisdom and understanding in these two old "saws." The more thoroughly a person absorbs and makes part of himself the real spirit and intent of their real meaning, the more useful will that person be to himself, to the world at large, and of the greater especial value in his particular vocation.

The value of materials and supplies purchased annually by the railroad forms a goodly proportion of the cost of yearly operation. The first cost of any article is not the sole basis of that article's value. Price is but one component part in the determination of values, therefore, care needs be exercised in the preparation of specifications covering that which is to be purchased, that they are not so worded as to cut out legitimate competition in your purchases. To make your requisitions of purchase call for so many boiler tubes of some particular copyrighted brand;

or for so many pieces of boiler plate of some special manufacture; or for so many bars of some particular brand of staybolt iron; or for so many dozen of some particular make of track shovels, etc., etc., is not to provide your buyer with specifications, but tends only to annul the sole intent and purpose of the office of purchasing agent.

We will agree, as a general proposition, that a person who makes a specialty of manufacturing any one thing will be better posted regarding the details of that particular business, than one whose time is necessarily divided between a great variety of subjects other than materials and supplies, and of most articles used in railway operation there are several reputable concerns engaged in the production of each line of goods.

Specifications are sometimes so worded that the manufacturer is told just how he must make the article desired, and then told the particular results that he must guarantee that particular article to yield the purchasing company.

Your speaker believes in specifications, but not in hobbies.

There is nothing purchased but what, speaking generally, should be bought under specifications, but—and here's the rub.

A school teacher of the speaker's boyhood days, once said: "Its those 'buts' to the boys, that spoils the whole thing. There's such and such a boy—he is all right; *but*"—"Johnnie so-and-so is all right, *but*"—and it was what followed the "*but*" that spoiled the boy's record.

But the specifications should be such as to clearly place before the several manufacturers the result to be accomplished, and the accomplishment of which it is your intent to hold them accountable for, rather than to have the specifications so drawn that the purchase price is the principal thing affected, and that in an upward direction. It is either the misfortune or good fortune of your speaker to have had several years' experience, both as a purchaser and as a seller, and in the latter capacity he has frequently "gone up against" a phase of the "specification argument" that is quite familiar to many of the members of this body, and where the specifications were so worded that the speaker's bid could not be entertained because his articles did not have quite the proper ingredients in quite the proper proportion.

One of our members not long ago, very courteously referred to a letter your speaker had addressed him, upon the question of the specifications for air brake hose used upon the line with which the speaker is connected—and more or less discussion followed in one of the railroad papers. The writer's experience from that date to this, fully justifies the position he assumed in these discussions, and he still continues to purchase air brake hose upon the broad specifications of a guaranteed service. Experience has taught the requirements of a hose capable of resisting a specified pressure, and that in average service should yield certain results; what more do you want of a reputable manufacturer than his guarantee of that result in service?

Broadly speaking, this should be the sole aim of all specifications, namely, guaranteed service. Let the several heads of departments recognize the fact that, as they are unquestionably much better fitted to have charge of the work assigned them, so is it possible that the man doing the buying may perhaps be a better trader than they, and the better fitted for his particular duties. Mix these two

good things together and so get the full capacity of both wheels of the clock—and don't handicap your buyer with specifications that some interested person may have helped suggest; and when the purchasing agent asks for prices, the purchasing agent gets the "cold laugh, ha! ha!" and "I'm specified."

Specifications can always be so drawn that they will secure the service desired, and, at the same time, not shut out competition from any reputable manufacturer and, therefore, secure to the road the one result that should always be sought viz., the best value for one dollar invested with the necessary attendant reduction in the operating expenses of the railroad.

Buying is fully as much an art as is any other branch of the railroad service, and the buyer should be selected with as much care as to his fitness for the place as is the apparent intent in engaging the services of the president.

It requires more than one man to run a railroad, or there would never be but the one man on a railroad but, as before stated, the several officials and subordinates must unite in the one grand aim of increasing the sum placed annually to the credit of profit and loss account, or the railroad cannot continue to exist, and no branch of the railway operation offers a better field for saving than that which can be accomplished by taking the buyer into your confidence in all departments of the service, and secure his co-operation in the preparation of all specifications and, subsequently, by keeping him fully advised as to the practical results obtained from using the things bought, remembering that the lowest priced article is not necessarily the best value, neither is the highest priced article by any manner of means always the best to purchase, and strive to each keep in touch with the other, laying aside personal ideas as to which is the greatest, and keep your eyes concentrated solely upon the right hand side of profit and loss account, and do those things which will increase the profit from operation.

Whilst not entirely germane to the subject, your speaker begs to suggest that it will be conducive to the economical operation of the railroad if the heads of the several departments will consult freely with the purchasing agent in the matter of ordering various articles for trial purposes, and provide for the purchasing agent making the necessary purchase order for the articles for trial, and so arrange that all reports with regard to the performance of the trial material shall be issued through the purchasing agent's office.

It is far from the speaker's desire to undertake to create the impression that the purchasing agent's office is the one central pivot around which, or upon which, the entire railroad organization rotates, but from past experiences gathered from a rather active experience both as a seller and a buyer, your speaker is confident that the observance of the spirit of what has been said upon the subject of "Purchasing Under Specifications" will conduce to a material reduction in the operating expenses of the road.

The subject has not been exhaustively handled, and is one which a great many other persons could probably treat to much better advantage than the speaker; however, what has been said has been given out through a desire to reciprocate the helpful thoughts which the speaker has received from the other members of the Club, and because of the speaker's desire to do all that he can to extend the usefulness of this organization and, at the same time, do all that is possible toward the advancement of the service of railroading.

President Hetzler: Mr. Hubbell's paper is of interest, as he states, to both the seller and the buyer. The seller in this case is represented here this afternoon by the supply men, and the buyer by the railroads. We have a number of representatives on both sides, and the chair desires that the time will be fully occupied in discussing this question pro and con. I hope that it will not be necessary to call on individual members, as I much prefer that the discussion would go on voluntarily.

Mr. Yeomans: I feel rather flattered at being invited to take part in the discussion of this interesting subject, particularly as I have not the honor of being a member of this organization. But in another sense the compliment is rather doubtful, in that I am asked to add something to a subject that it seems to me has been very exhaustively covered in a precise and able way. I think my task would have been much easier if Mr. Hubbell had not so clearly and fully expressed my own views in the matter. There is really nothing left for me to say, except to elaborate on one or two points that he has presented.

Among the fundamental rules laid down by the president of a certain railroad company, which I once had an opportunity to examine, was the following: "Requisitions must not be made for special brands or manufacture of supplies or materials, but may call for material to stand certain tests or requirements which shall, whenever practicable, be in accordance with such standard specifications as may have been adopted by the company." This rule reaches the very root of the correct theory of railway purchasing, and, in my judgment, should form a part of the code of every well organized railroad. It makes purchasing under specifications one of the cardinal features of the service.

The refuge of the purchasing agent is the specification. It places in his hands the sword of fair and legitimate competition, and the shield of intrinsic values. Behind it, he can successfully withstand the assaults of those who are armed only with well advertised brands or highly embellished trade-marks. If the specifications themselves rest on the broad basis of common sense, and are modeled on the lines of actual service experience and mechanical practicability, his position is impregnable. This brings us naturally to the framing of the specifications under which the purchasing agent is to act.

They must necessarily be drawn by the experts in charge of the

mechanical or engineering departments, but even here the commercial training of the purchasing agent may be made useful, to a certain extent, in an advisory way.

If he has been selected with special reference to his fitness for the position, he should have, at least, a good general idea of the methods employed in the manufacture of all the most important kinds of material which he buys, and especially of those mechanical limitations which have a direct bearing on the cost of production. The first aspect in which any given question presents itself to a buyer is that of cost, while at times this may be temporarily lost sight of by the expert, intent only on the results to be accomplished. Besides this, if the purchasing agent is consulted when the specifications are being prepared, he becomes aware of the exact results aimed at, the reasons why certain requirements are considered necessary to such results, and is enabled to act more intelligently in his subsequent dealings with the manufacturers.

Among the numerous specifications for material that continually come to my notice, there is here and there one which indicates a tendency to dictate the methods by which certain results are to be accomplished. This tendency should be avoided. A specification should attempt only one thing, namely, to point out to the manufacturer the qualities desired in the material, and the means which will be employed to ascertain the presence or absence of those qualities, leaving him free to produce them in his own way, and holding him responsible for results by rejecting any inferior material that may be offered. It is here that the well equipped chemical and physical laboratory comes into play as a vital part of the system of purchasing under specifications. Without its efficient aid the whole organism is practically inoperative. While it is well enough in one sense to purchase material subject to a guaranteed service, there are numerous objections to the application of such a principle in its literal sense.

It is true that the chemical and physical tests may be said to represent approximately the requirements of service. Indeed, that is their object and their function, but in these days we cannot await the verdict of actual trial except in cases of unusual importance, or where time is not an object.

The laboratory reports should be the purchasing agent's professional bible. By their careful perusal and analysis he is able to judge

which of the various makes of similar material is most uniformly of good quality, and often to decide without hesitation between two or more similar articles which are offered at the same price. They should form as necessary a part of his records as the invoices for the material which he buys, and should be his vouchers for the quality of the materials which he has purchased under specifications.

I am heartily in sympathy with the idea that the purchasing department should not be considered as a separate and distinct institution, but rather as a co-operative branch of each of the three great departments to which the operation of the modern railroad is entrusted ; and that the purchasing agent should be, ex-officio, a member of each of them, as an expert in his particular line.

When the reluctance of the purchasing agent to expend the funds of the company in what may seem to him needless extravagance is regarded in its proper light, as being his modest contribution to the welfare of his employers, and not as a mere attempt to magnify his own importance by opposition to the wishes of some other official, much will have been gained. The day which sees the purchasing agent recognized as a welcome member of each of the other departments, and one whose co-operation is cordially invited in the inception of all matters which will necessarily pass through his hands in their final stages, will witness the inauguration of practical and intelligent economies in the railroad service that can be attained in no other way.

Mr. R. H. Soule : One of Mr. Hubbell's conclusions, it seems to me, is susceptible of some discussion. I refer to the paragraph at the foot of page 2, which reads : "Broadly speaking, this should be the sole aim of all specifications, namely, guaranteed service."

In my experience I have found that it is sometimes very difficult in practice on railroads to follow up a service guarantee, and, therefore, am of the opinion that the usefulness of a service guarantee should be measured by the feasibility of applying it successfully in service.

To illustrate the point, I will refer to the fact that, for instance, it is very difficult and almost impracticable to follow up a service guarantee of spiral springs, such as are used in the draft gear, or in the bolster springs of freight cars. Similarly, it is difficult and almost impracticable to follow up a service guarantee for such things as boiler and firebox plates, or for staybolts, whereas, on the other

hand, it is practicable to follow up a service guarantee, expressed, either in time or in mileage, for such things as elliptical springs or semi-elliptical springs as used under locomotives or passenger equipment cars.

From the nature of the conditions it is possible to measure the service performance of locomotive springs and springs which are used under passenger equipment cars, because each spring carries its own record in the shape of mileage, which is very carefully recorded for those classes of equipment, whereas, freight equipment cars run everywhere and their mileage is made up partly of home mileage and partly of foreign mileage, and it is difficult to accurately follow up a service guarantee of springs under them.

Therefore, it seems to me that Mr. Hubbell's statement ought to be modified so that it would read that the sole aim of all specifications should be either guarantee of service or guarantee of quality, because, where you cannot follow up a service guarantee, the only recourse you have left is to draw up the specifications in such a manner, and specify and apply such tests to the articles, when purchased, that you are sure that they conform to the specifications.

With regard to the clause which refers to the desirability of having the different officers secure the co-operation of the purchasing agent in the preparation of the specifications, would say that on the last road with which I was connected, the Norfolk & Western, it was the practice, when a new specification had been developed and was under consideration, to prepare half a dozen carbon copies and send the whole lot to the purchasing agent; the purchasing agent would then distribute the copies among as many reputable manufacturers and receive their criticisms. These, when collected by the purchasing agent, were covered by his comments, suggestions and recommendations, and finally came back to the motive power department, when the final approved specification was evolved.

As regards always consulting with the purchasing agent before agreeing to make trial of devices, I think that in some instances this would be difficult to carry out. The purchasing agent and the superintendent of motive power may be located at separate points. It often happens that the representative of a manufacturing concern will come along with a new device, and bring it to the attention of the superintendent of motive power, and he feels it to be quite within his power to agree on the spot to a trial of the device, especially if there

is no cost involved; this seems to suggest that it is at least difficult to always comply with Mr. Hubbell's suggestion, but I am, however, heartily in sympathy with his other suggestion, which recommends that reports on trial devices should reach the manufacturers only through the purchasing agent.

Mr. F. H. Stark (C. L. & W. Ry.): I have not given the subject of the paper much thought, being occupied with other things. I am fortunate, however, in being connected with a road whose officials are, as it were, one happy family. From the president down, it is our custom to get together and confer with each other as to the purchases, guarantees, etc. With small roads, however, it is difficult for them to prove everything by analysis, for many roads are unable to have a laboratory for testing materials. It is our purpose to buy wheels, air brake hose, metal brake beams and the patented articles, at least, on guarantee. Of course it is impossible always to follow that up to the letter, but it is our purpose, at least, to live up to the spirit of the contract.

In purchasing bar iron, and other common commodities of that sort, we usually buy of one or two different concerns, and there are no specifications that follow our requisitions for such things. If, however, the material is inferior, the matter is taken up and adjusted.

There are a great many things connected with the making of requisitions that it is very difficult to be specific about. I know our purchasing agent has to inquire nearly every month as to what we want. If we ask for so many handled axes, it is necessary for him to know what weight of axes we want, and so it is with handsaws and a great many other articles.

In conversation with our purchasing agent, recently, he suggested that he thought it would be a good idea if he had a sample room, in order that he might keep a sample of these articles, and after an order had been filled that one of these articles be sent in to the purchasing agent. I assured him that he would require quite a large room and thought it would be better if he would make a trip once or twice a month to the shops.

I believe it would be a good thing for the mechanical department, and also the purchasing agent, if the purchasing agent would go to the shops and investigate for himself, and familiarize himself with the articles that are bought. I realize it is very difficult for the purchasing agent to decide between one article and another, simply

because it is impossible to tell what they are bidding on, and it is absolutely necessary that the purchasing agent and the heads of the various departments confer with each other very freely on all these subjects.

MR. F. W. SARGENT (Sargent Company): As a supply man I am heartily in favor of specifications. You can tell the supply man what you want in as plain terms as you can, but I believe the specifications ought to be short and sweet. I think a great many of the specifications are entirely too long and that they entail hardships sometimes on the manufacturer in living up to the details of the specifications that makes the work too expensive.

In our business we like to know what our customers want, and then we try to give it to them as nearly as we can.

The specifications on steel castings should be short, although some of the specifications I have seen for steel castings are rather hard to live up to to the letter. We have had specifications calling for basic steel, and of course we sent them back and asked for new instructions; and we have had specifications requiring that the heat number be stamped on every casting on an order for a lot of castings that would not take the heat number. We have had specifications calling for test bar on steel castings, where the test bar would be larger than the castings, and if we live up to those specifications we will get into trouble. But, if anything, specifications should be given to all the manufacturers, for their guidance, and then they know what to do.

MR. M. H. WICKHORST (C., B. & Q. R. R.): I very heartily agree, as one in charge of a testing department in a general way, with the remarks made by Mr. Hubbell and Mr. Yeomans, and I am very decidedly of the opinion that we ought to have specifications in general for material; that material ought to be bought to specifications, where practical, rather than to a guarantee of service, that is, if you can draw the specifications so as to decide, when you have received the samples, or when you have received the goods, whether or not you want to take them, prepare the specifications, make your tests and accept the material and let that be the end of it. That certainly would mean a great deal less clerical work and less worry, it seems to me.

In drawing up specifications, of course it should be the object to first of all know just exactly what you want. That is, find out just

exactly what qualities you desire the materials to have, then draw up the specifications in such a general way as to obtain those qualities and leave out the inessential details.

I very frequently have occasion, by reason of being in charge of a test department, to find out the actual value and the necessity of inspecting material to see that we get what we want.

For instance, I remember an order was placed for a lot of couplers, with a new firm. We heard very good stories of what the couplers would stand, but as a matter of fact, when I tested the first lot of couplers I had to reject them. Some few changes were made in the foundry, and after that, the second or third lot, and all subsequent lots, when submitted to us, came up to the specifications, and we undoubtedly got, say 30 per cent more service out of those couplers, simply due to watching the material to that extent.

After we get into the habit of inspecting material and watching it, there is very little trouble, indeed there are very few cases where material has to be actually condemned. It will not happen more than several times during the year, but we frequently do have cases where there will be some defect in the material. Then we simply call the manufacturer's attention to such defects and generally have the matter remedied in the next shipment.

Mr. F. A. Delano (C., B. & Q. R. R.): I did not intend to say anything on this subject, but I want to testify to the one point that is made by Mr. Hubbell and also by Mr. Yeomans and Mr. Soule in their remarks, and that is, on the subject of the value of co-operation between the various operating departments of the railroad and the purchasing department.

That phrase is such a hackneyed one that it does not always mean as much as it ought to. In order to get the co-operation that is really necessary, it involves, to my mind, something that does not exist on many roads, namely, that the heads of these various operating departments, and by that I mean the maintenance of way, the maintenance of rolling stock, and the transportation departments should be located in the same office building, or at any rate, as close at hand as possible to the head of the purchasing department. In my own position that closeness of touch to the purchasing department has been of great value to me, and when I go to the office of some superintendents of motive power, and find them quite a distance off, sometimes many miles from the head office, and the office of the

purchasing department, I cannot help thinking that they are at a great disadvantage. By co-operation we mean that the purchasing agent should be taken into our confidence, that he should attend meetings at which mechanical men are discussing the needs of the department. In my own case, on the C., B. & Q. Road, Mr. Yeomans knows as much of many mechanical details—more, I might say—than I do, and he comes up and gives me suggestions, and occasionally I go down to his office and usurp the prerogatives of purchasing agent. But all goes on very smoothly ; it is a sort of give-and-take arrangement.

Mr. E. E. Russell Tratman (*Engineering News*) : There is a very important statement made at the bottom of the first page, which might be printed in capitals, I think, as a principle for heads of departments, purchasing agents and railway officers in general : "The first cost of any article is not the sole basis of that article's value. Price is but one component part in the determination of values."

I think the blame which is cast on the purchasing agent generally comes from his not observing that principle, at any rate, that is very often the opinion of the man for whom the purchase is made. The purchasing agent can hardly be expected to be anything more than an office man. If he was to be an expert in all the various articles, he would probably be the president of a railroad, but not a purchasing agent. On account of his not being an expert in every department, if the head of a department wants any special article, the purchasing agent is apt to think it is a fad, and that one article of its kind is as good as another, and if the price is pretty close, the cheapest is the best. If he will get around the shops, as much as time will permit, it will be a good thing for all concerned.

Guarantees do not always guarantee. I know of a case where a reputable firm gave a guarantee and that article failed altogether, that is, it failed to come up to the guarantee requirements. I presume there was some kind of penalty attached, but I doubt very much if the penalty compensated at all for the loss of time and trouble in putting in the article, trying to make it work, worrying along with it for a time, finally throwing it out, and getting a new requisition, ordering a new machine and going through all the same business over again. In another case that I know of, a salesman agreed to all the terms of the guaranty, and the contract was closed. When the

contract reached the head office, the firm promptly repudiated it. Then the railway company had to get a new set of bids again. It might be asked, what is a reputable company, and what is to settle the reputation of a new company introducing some new and promising articles or supplies?

I do not know how we are going to straighten things out very definitely, except in the way Mr. Hubbell suggests, by a much closer relationship between the heads of departments and the purchasing agent. Then the "heads" will be apt to take the commercial side of the question into greater consideration. The purchasing agent, also, by this closer relationship, will be able to understand that preference for certain articles or supplies is not necessarily a fad, but that the demand is based upon experience. For instance, Mr. Hubbell refers to staybolt iron. There are various kinds of staybolt iron, and to most purchasing agents staybolt iron is staybolt iron. But to the men in charge of the locomotives there are certain grades that are better than the others under certain conditions, for their roads at any rate. These irons are a special make. The department will try to get that special make, and they have often a very hard job to persuade a purchasing agent to buy them. He simply wants to buy staybolt iron, and the cheapest that comes along is the best. And then perhaps he wonders why he is blamed because it does not give the results that are wanted. The same remarks apply to oil and many other supplies.

Mr. C. H. Hawkins (Republic Iron & Steel Co.): I have had some experience in working to specifications. Several people here today have caused me considerable worry on this point, especially one in whom I am glad to note a change of heart, as he is now a manufacturer.

I think the trouble in working to specifications is the want of uniformity. I am speaking as they apply to metals. Each road, for general use, calls for a grade of iron special to itself. Some requirements are easily met by the mills at a moderate cost, others are impracticable, and can only be secured at too great cost for general use. The purchasing agent of a railroad is not only a buyer of new material, but he is also a seller of old or raw material, which enters largely into the new product he buys, and this old material contributes to reducing the cost of manufacture. In my opinion, a specification for bar iron or iron axles should be drawn so that this waste

material can in part be used in the manufacture. I know of no specification for bars whose requirements cannot be met at a price, but there is no mill that can produce at moderate cost a grade of iron that will stand 50,000 pounds tensile and give an elongation of 25 per cent in 8 inches.

In this connection I will try and answer an inquiry of Mr. Yeomans of a few days ago, namely, how the test of a coupon taken from the side of a steel plate would positively represent the quality in the body of the sheet. For all ordinary purposes the ordinary mill practice does this, but it does not always absolutely represent the interior. The edges of the sheet sometimes show lamination. Coupons should be taken far enough from the outer edge of the sheet so as to embody a part of the solid plate ; of course, to do this will increase the percentage of waste which the consumer will have to pay for, but it is the only means by which the test coupon will actually fairly represent the interior of the plate.

Mr. William Forsyth (C., B. & Q. R. R.) : The gentleman has suggested a subject I once discussed at another club, that is, the feasibility, the wisdom and advantage of adopting standard specifications.

Now, I would like to bring up the question here with the railroad people and with the supply people, whether it would not be an advantage to each if the Master Mechanics' Association could adopt standard specifications for the majority of materials which are used in that department of railroads.

Mr. J. F. Deems (C., B. & Q. R. R.) : If I read this paper rightly it is not in favor of specifications, as we usually apply that term, but in favor of buying on a service test, I believe. At the bottom of page 2 it says, "Broadly speaking, this should be the sole aim of all specifications, namely, guaranteed service."

A thought that occurs to me is that there are many things on a railroad that it would seem to me a supply man could hardly sell in that way. For instance, take the items mentioned here, boiler tubes. The life or service of a boiler tube depends, nine-tenths on the way it is applied as against one-tenth on the quality of the material.

Now, you take bearing metals, and a great deal depends on the treatment in service, so that it seems to me, taking that statement broadly, as it is made here, it is very difficult indeed to apply it.

It would seem to me it would be quite impossible for supply men to sell many things on a guaranteed service test. The question will come up as to who is at fault in case of failure, because in many of these things the work of applying it is of so much more importance than the material itself, and the treatment that it receives in service, the life of the material, so to speak, depends so much more on that than on the quality of the material to start with. It seems to me there is no way of buying those things except on specifications.

Many other things might be enumerated, but these are a few of the thoughts that occurred to me.

MR. HUBBELL: Mr. President, it was not my thought in any way to undertake to tell just exactly how purchasing under specifications should be conducted. I simply jotted down the thoughts that came to me on the subject, revised the paper and handed it to our Secretary.

It has been said that if we wish to get at a book, that we can do so only when we have first ascertained what was the author's thought, the author's intent, and so, generally, you must take what I have said with regard to the purchasing under specifications, that is, more with the spirit that is intended to be conveyed than perhaps the exact letter.

Referring to that portion of the paper to which Messrs. Soule and Deems make special reference—"Broadly speaking, this should be the sole aim of all specifications, namely, guaranteed service." The language implied in that hardly conveys the meaning I had intended. I have not meant to decry specifications, as was developed in the remarks of one of the speakers. I believe in specifications, and I think I have stated that fact, but I am everlastingly against hobbies, because, in my experience, I have seen just exactly where they led to the wrong results.

As an illustration, a certain superintendent of machinery, not long since, sent a requisition to his purchasing agent for a certain machine tool. It so happened in this particular instance, of which I have rather full knowledge, that the purchasing agent was thoroughly conversant with machine tools; he had had considerable experience with them. The purchasing agent was instructed by his management to buy that which the requisition specified, but this fellow was something of a trader, and he thought before placing that order it might be wise to get a price, and he got a price not only from the maker of this one tool, but from other makers of a similar tool. They were not all alike, of course, but you will find some of the makes of all these

makers in some of our railroad shops; they are all doing business, and, I presume, likely that each one of the manufacturers will produce the usual list of testimonials, longer than your arm, saying that the tools are all right. The order was finally placed for the tool specified in the requisition at a little better price than had been named to the superintendent of motive power when he made the requisition specifying the tool. After some time had elapsed after the placing of the order, in response to a punching up from the office, they advised the purchasing agent that they were unable to furnish the tool.

This will answer the gentleman on my right, who attacked the question of the wisdom of the purchasing agent being allowed discretion in these matters. In this particular case, had the purchasing agent been allowed to exercise his discretion, he would have saved the company a little over one hundred dollars in the first purchase price, and they would have had the tool in use in their shops all this time. As it is, they have not got it and will not have it for some sixty days yet, and they will have to buy it where that purchasing agent was first inclined to buy.

Now, in regard to staybolt iron, there is staybolt iron and staybolt iron and still some more. There are, however, a number of reputable concerns manufacturing staybolt iron, and I know something about staybolt iron that I am not going to tell in this meeting.

I have made the statement distinctly in the paper that price is not the sole basis of values. There are only certain articles that I purchase wherein price is my guiding star. There are some things that I buy, that I buy solely on the basis of price. For instance, monkey wrenches. A railroad's consumption of monkey wrenches is not in the use of them, but the main source of expense in that line is from theft, and it is poor policy to buy the best, as a general proposition.

On boiler tubes, I believe in buying boiler tubes on master mechanics' specifications; by that I mean specifications of the Master Mechanics' Association.

I hope that in these supplemental remarks I have made, I may have been able to give a little clearer idea as to what I mean in regard to the guarantee of service. It is comprehended in your specifications, but word your specifications so that the result will not be to accomplish that which the gentleman sitting in front of me has just said, namely, an increased cost of the article purchased, thereby increasing your operating expense and decreasing the sum to the credit

of profit and loss account. It is the sum placed at the right hand side of "profit and loss" account annually, which affects the salaries of railroad men, and that is what personally interests you.

President Hetzler: If there are no further remarks on this subject, we will proceed to our next paper, namely, "Notes on a bending test of an M. C. B. arch bar truck," by Prof. C. V. Kerr.

Notes on a Bending Test of an M. C. B. Arch Bar Truck.

By Prof. C. V. Kerr,
Armour Institute of Technology.

Some months since, some tests were made at Armour Institute of Technology on an M. C. B. arch bar truck, which are thought to be of enough interest to bring before the Club.

The truck, before tests were made, is shown in Fig. 1. The load was applied

Fig. 1.

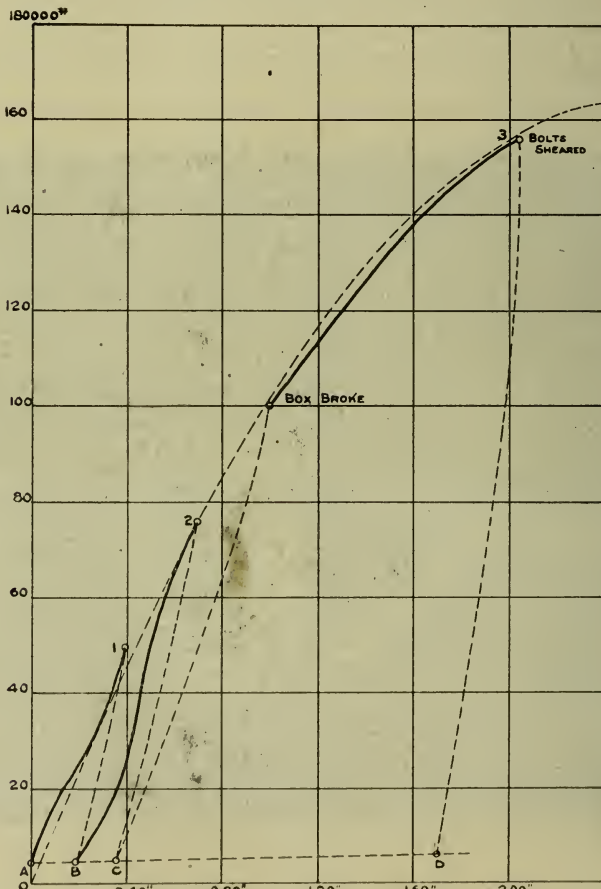
at the center by short lengths of I beams, so placed as to distribute the load in the ordinary way. The car axle was represented by a short piece of shaft, supported at each end, and in turn supporting the end of the truck with the brass in the usual position.

Three series of loads were applied to the truck with the purpose of ascertain-

ing its behavior, both under load and upon release. The loads were applied by means of a 200,000-pound Riehle testing machine, which was in good order and accurately balanced. The measurements of deflection under load, were made to 0.01 inches by scales at each side of the truck.

The first series began at 4,900 pounds, the initial load being made somewhat high in order to remove the set due to taking up the slack in bolts and fittings. A gradual increase in load to 45,000 pounds resulted in curve (1) Fig. 2; on release an amount of set represented by *ab* was found.

The second series of loads resulted in curve (2) Fig. 2, the highest load being



M. C. B. ARCH BAR TRUCK
WEIGHT, 650#
FIG. 2.

75,000 pounds, with a set *ac*. Then, without noting deflections, the load was increased to 99,500 pounds, at which the journal box broke. A further increase

of load, to 155,800 pounds, gave curve (3) Fig. 2; and the tests terminated with the shearing of the bolts, as shown in Fig. 3. The boxes crumbled in the manner

Fig. 3.

indicated. On account of the method adopted of supporting the ends of the truck, the boxes were cut so as to be materially weakened, and, consequently, failed sooner than they otherwise would.

With a truck loaded in this manner, the upper bar is in compression and the tendency is to straighten out. The middle bar is in tension, and tends to double up; the lower bar is also in tension with a like tendency. The result of the opposite forces in the upper and middle bars of the truck is the shearing force, which finally causes the failure of the bolts.

The relative movement of these bars is clearly shown by a comparison of Figs. 1 and 3. The attention of those who are intrusted with the design or loading of such trucks is especially called to this shearing stress, as all of the tests of built up beams made at the Institute have resulted in ultimate failure of the beam by shearing of bolt or rivet connections. It seems to be a point to which designers give little or no attention.

The construction indicated by Fig. 4 is found on tender trucks, and occasionally on freight car trucks. It is a much stronger design, since the lug on the end of the middle or tension bar gives direct support to the upper bar. It will cost more to make the bar in this way, but the middle bar has far more tensile strength

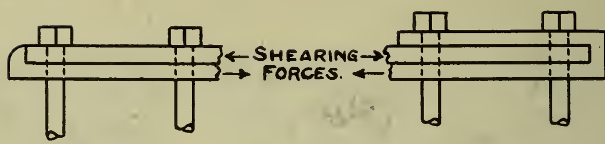


FIG. 4. FIG. 5.

than is called for, and possibly enough material could be saved to offset the extra cost. And if made thinner than the upper bar, the construction in Fig. 5 could readily be adopted. For thin bars it would probably be the better of the two.

PROF. C. V. KERR (Armour Institute of Technology): I made this paper short enough so that I thought all of you would have time to read it, but I find on reading it over again myself that there are things in it which will bear explanation.

Possibly I ought to apologize for tendering you so short a paper in the first place, but its shortness is due chiefly to the fact that this particular truck was tested in competition or comparison with a patented truck, the owner of which did not care to have results published, although I may say that they were rather complimentary than otherwise.

The load was put on this arch bar truck in such a way that, excepting the shocks, the actual conditions of loading in service should be as closely counterfeited as possible. The short I beams referred to, were loaded crosswise of the truck on the lower bars, and the load was, by means of other short I beams, set up lengthwise by side beams, so that the moving head of the machine brought the load on the lower bars of the arch bar truck. The cutting away of the boxes on the side was necessary on account of the limitations under which the work had to be done.

On the second page of the paper is the set of curves showing the results of the three series of loadings that were put on. We put on about 50,000 pounds and then went back and took the set in order to avoid going beyond the elastic limit of the truck as a whole, before making final test of its strength. The curve which is shown is somewhat peculiar, but we took readings of the deflection on each side of the truck, to the one one-hundredth of an inch, so that the curve was definitely located.

When we put the load up to 50,000 pounds and released it, we found a permanent set which was, roughly, .2 of an inch, shown by *ab* in the figure. Then from the point *b* the readings trace the curve to the point 2, at which we have nearly 80,000 pounds laid on the truck. Then we released it, finding the set *ac*. Then we put the load up to nearly 100,000 pounds, at which we have the words, "box broke," that is, the box crumbled up, being pushed over sideways by the action of the strain. Then the load was continued until we had the final failure, the shearing of the end of the bolts, that is, at nearly 160,000 pounds.

On the third page is a statement which seems contradictory at first sight; that is, that the upper bar is in compression and the tendency is to straighten out. That tendency to straighten out is brought about by the through bolts or vertical bolts on either side of the springs, and on either side of the loading as we put it on. That, of course, tends to bear down on the upper bar or arch part of the compression member, and so tend to straighten it out. Now the middle bar is in tension, and things in tension usually straighten out, but in this case it tends to double it up, bringing the ends nearer together. The same tendency is true in the lower bar.

Now, I wish to make this one point in connection with the paper, and for the reason that I did not want to obscure that, I left some other matters out, and that is, the ultimate failure, aside from the crumbling of the boxes, was the shearing of the bolts on either side of the journal box. The upper plate tends to move upward, as shown in Fig. 3, and the middle bar tends to pull inward; that brings the single shear strain on those bolts. I might add also that of a number of different forms of built up beams which we have tested, that ultimate failure has invariably been through the shearing of connections. For this reason I call attention to this point especially, because it is possible to so design a built up beam that very much better results can be obtained.

One beam that was built up, a rather complicated beam, relatively, of two ordinary single beams which we tested, gave almost as perfect an elastic curve as a single piece of the same quality of material in direct tension. I mean by that, if you refer to the curve in Fig. 2, taking curve A, 1, 2, 3 of the elastic limit on that curve, this particular built up beam acted almost as if you had a piece of its metal in direct tension. That indicates to what point good design will bring a built up beam so far as its performance is concerned.

At the end of the paper are some facts stated and opinions given which you are at entire liberty to take for what they are worth. Fig. 4 represents what you already know as being in practice; Fig. 5 represents a suggestion which will materially strengthen the beam, because in that case the compression member, which is the middle one, pushes outward and is resisted by the middle member lapped around it.

Another suggestion, made to me by an engineering friend, to the effect that taking Fig. 4, or the ordinary construction of the arch bar truck, it can be made materially stronger, so far as this shearing stress is concerned, by putting one or two countersunk bolts on the top of the box, with the nut on the top of the truck. That if you put two in, it will practically double the shearing strength at the end of this truck.

Mr. Stark: In regard to the results from this test, I infer that the failure resulted in the shear of the box bolts before the failure of the arch bars. In actual service we find that this is not the result; we find that the lower arch bar or the tension member fails nine times out of ten. It has been claimed, theoretically, that the compression member is the weak member, but where we have one top arch bar fail, we have nine of the lower arch bars that fail, and this has led us to strengthen somewhat the lower arch bars.

I believe car men lose sight of the fact that there should be a closer fitting of parts; it is generally desirable to have a liberal radius of the angles so as not to produce a sharp kink in the arch bar. This is very essential, and yet we should construct the column and the oil box so that the castings would fill up or hug the angle, and furnish a good bearing at the vital point, that is, at the angle.

I believe the lug on the end of the compression member is a good thing, although I cannot say that we have had any trouble with the box bolt shearing off. As to turning back the tension member over the top, taking in the two box bolts, I presume in that we would run up against a snag, for I understand that is patented.

Mr. Wm. Forsyth: Mr. President, Prof. Kerr has given the magnitude of the loads and the deflections for these tests, but he does not give the size of the arch bars. He refers to the M. C. B. truck, but I do not understand that you can define the size of bars by referring to an M. C. B. truck. I think the test would be more valuable if the size of the arch bar were given.

I notice the remark, "It seems to be a point to which designers

give little or no attention." The fact that a diamond truck has the top bar in compression and the middle bar in tension, and the result of this is shear on the bolt, is well known. It would not be at all complimentary, I think, to railroad mechanical engineers if they had disregarded this fact, because a freight truck is the most numerous structure of any ; it is the structure that is used in larger numbers on the railroad than anything else, and therefore it should be a proper subject for correct design and economical construction.

All the latest practice has plainly shown that there is no advantage in turning up the ends of the middle bar; that practice was used fifteen years ago, and was discarded as unnecessary. It has been found that in the rough work of a car shop such a fine machine fitting as would be required to make the shear of bolts coincide with the butting of the bar against the other end is not obtained; the result has been that you find freight trucks today with straight bars just as they are in the test, and I have no doubt that as the result of long experience and investigation as well, it is, all things taken into consideration, the best design.

Mr. W. A. Smith (Cloud Steel Truck Co.): The truck frame referred to in the paper of Prof. Kerr is the M. C. B. recommended practice for cars of 80,000 pounds capacity. It will be seen by the diagram that the elastic limit was reached at 45,000 pounds, and it is very evident that the arch bars were put out of serviceable condition long before the point was reached where the bolts were sheared. A certain master mechanic originally informed me that he had had a template made and had been testing all cars of 80,000 pounds capacity that came into his yards, and found that in a very large proportion of them the arch bars had taken sufficient permanent set to tilt the boxes toward each other at the top. It appears from this, that the arch bars reach their elastic limit altogether too easily and that there will be much resulting trouble from hot boxes, etc.

Mr. Hubbell: I am not able to say anything on this subject which will be perhaps of any special benefit, but I heard a paper read under the "Topical Discussions," at Saratoga, eighteen months ago, that interested me very much, about the arch bar truck, and since that time I have been watching the arch bar truck as perhaps never before ; and I have been surprised at the number of instances I have seen, under cars of various stenciled capacities, where the ends of the arch bars over the oil boxes were "cocked up," or, in other

words, where the arch bars had passed the elastic limit. I think perhaps, most of our members will be more or less interested in that same subject if, they make a specialty of it and watch it.

Mr. F. H. Clark (C. B. & Q.) : I agree with Mr. Stark, that the failure recorded by Prof. Kerr is not a very common one. I have seen very few cases of sheared journal box bolts. I saw some time ago a record of failures of truck side frames, and out of the entire number there was not a failure of the journal box bolts. The failures covered by the record were distributed in the ratio of about 77 per cent in the lower bend of the bottom arch bar, 2 per cent in the top bend of the top arch bar, 7 per cent in the bottom bend of the top arch bar, that is, out near the journal box bolt, and 14 per cent in the column bolts.

Now, I do not know to what extent those ratios will hold good, but I am of the opinion they are about right. In looking into this question some time ago, I investigated quite a number of trucks in common use, some of which were considered very good trucks and some of which had bad reputations ; I made stress diagrams for each truck, calculated the stresses in the arch bars and column bolts, and in calculating the stresses in the lower arch bar it was at first thought best to consider the section at the column bolt, as about one-third of the material was cut away at that point by the bolt. Upon looking a little further into the matter, it was found that we had very few failures of the arch bars at that point, the most of them being an inch and a half or two inches away, at the bend. As the stresses in the diagonals were greatest, we finally decided to base our stresses on them, and on this basis we found that in most trucks which apparently gave very little trouble, the stresses in the lower arch bars under a dead load were 2,800 to 2,900 pounds per square inch in the lower arch bars and 2,200 to 2,300 pounds per square inch in the top arch bars. These figures seemed ridiculously low; almost anyone would feel sure that the stresses might be considerably greater without hurting the trucks very much, and I came to the conclusion, after studying the thing over, that the life of the lower arch bar depends more upon the column bolt and the column bolt fastenings than upon any other thing, and that in order to make use of light material in the lower arch bar, it would be necessary to provide, in the first place, column bolts of sufficient size to safely carry the load, they having to carry practically all the load, and, in the second place, arrange a fastening of some kind at the lower end that would prevent the nuts

from losing off or slacking off; that the breakage of arch bars is not generally due to legitimate stresses or stresses ordinarily considered by the designer, but were due to nuts loose or lost off, which, of course, would greatly increase the stresses at the bends at the corner of the end castings or columns, on account of the bending and vibrating action that the arch bars there have to withstand.

THE PRESIDENT: If there is no further discussion, I will ask Prof. Kerr to close the discussion.

PROF. KERR: I find that some points have been brought out in the discussion which show that I have unwittingly recommended, in Fig. 5, a patented article; I was not aware of it, and I see that makes it all the worse if it has been tried and failed.

I purposely commented rather severely on this question of shear, because I wanted to bring out discussion on that very point, and I am obliged to my friend Mr. Clark for the data which he has given in regard to the failures of these arch bar trucks. I presume you gentlemen will remember, in the study of beams, that they were generally considered as solid beams, and that your ideas as to the action of shear were at first, at least, somewhat vague. I really believe, notwithstanding what has been said here, that our experience in testing these beams shows that the ideas of, at least, some designers are still vague, because ultimate failure, as I said, invariably resulted in the shearing of these bolts which affect the moving of one part of the beam over another part. The ideal arch bar truck would be, of course, so proportioned in its different parts that, like the "One-Horse Shay," it would be equally liable to fail or equally strong at all points.

On account of using cheap iron, with a low cross bending strength, it is perhaps advisable in practice to use considerably heavier members in tension and compression than are necessary, at least so far as tension is concerned. Not one of the tests showed any weakness so far as tension of any members of the truck were concerned. It is in the cross bending of these that failure occurs, as Mr. Clark has brought out, and in the shearing of the end bolts.

Adjourned.

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1895—Apr., Sept., Oct., Nov., Dec.

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March	12 "	September	12 "
April	20 "	October	4 "
May	26 "	November	12 '
1892, April	32 "	December	12 "
September	15 "	1897, January	1 "
November	17 "	February	1 "
December	10 "	March	1 "
1893, January	29 "	April	3 "
February	3 "	September	1 "
March	10 "	October	1 "
April	7 "	November	39 "
May	15 "	December	188 "
September	5 "	1898, January	133 "
October	12 "	February	134 "
November	32 "	March	55 "
December	22 "	April	8 "
1894, January	6 "	May	181 "
February	3 "	September	165 "
April	1 "	October	68 "
May	4 "	November	171 "
October	3 "	December	71 "
1895, February	1 "	1899, January	67 "
September	26 "	February	128 "
October	36 "	March	47 "
		April	32 "
		May	12 "
		Total	2,096

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

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THE regular monthly meeting of the Western Railway Club was called to order at 2 p. m., Tuesday, April 17, 1900, in the Auditorium Hotel, Chicago. President H. G. Hetzler in the chair.

The following are the names of those who registered:

Allen, G. G.
Anderson, Geo. T.
Anderson, Thos.
Angell, F. R.
Ball, H. F.
Balten, Perry H.
Bischoff, Geo. A.
Blanchard, W. H.
Bradeen, J. O.
Brankin, Edw.
Brown, Geo. H.
Bryant, W. E.
Burtis, A. B.
Bush, S. P.
Carroll, Jno. T.
Carse, David B.
Church, H. L.
Conger, C. B.
Cosper, W. P.
Cota, A. J.
Dean, N. C.
Deibert, F. W.
Deiman, C. W.
Doebler, C. H.
Gilmore, W. L.
Goehrs, Wm. H.
Goss, Prof. W. F. M.
Grafstrom, Edw.
Graham, J. A.
Groobey, Geo.
Hayden, N. L.
Henderson, Geo. R.
Hennessey, J. J.
Hetzler, H. G.
Higby, Theron
Hubbell, Ira C.
Jacoby, W. L.
James, T. H.
Johann, Jacob
Keeler, Sanford
Kirby, T. B.
Lane, F. W.
Luttrell, J. W.
MacBain, D. R.
Marshall, W. H.
McAlpine, A. R.
Meadows, D.
Medway, John
Murphy, J. P.
Parish, L. G.
Peck, Peter H.
Perry, A. R.
Pettis, C. D.
Quereau, C. H.
Reilly, T. S.
Reynolds, A. R., M. D.
Rhodes, G. W.
Riddell, Chas.
Rogers, M. J.
Rossiter, S. W.
Royal, Geo., Jr.
Sanborn, J. G.
Sawyer, E. C.
Schubert, Jno. C.
Sharp, W. E.
Shillinglaw, Thos.
Slaughter, G. F.
Smith, R. D.
Spear, F. R.
Stark, F. H.
Taylor, J. M.
Taylor, Jos. W.
Thompson, E. B.
Tratman, E. E. Russell
Terrell, Cory D.
Tucker, A. L.
Ward, M. E.
Wharton, R.
Whiting, Geo.
Wickersham, R. S.
Wolgemuth, L. E.
Woods, J. L.

President Hetzler: The minutes of our last meeting will stand approved, as published, if there are no corrections. I will ask the Secretary to read the names of new members, as approved by the Board of Directors this morning.

The Secretary then read the following:

Geo. G. Yeomans, P. A., C., B. & Q. R. R., Chicago.
B. H. Hawkins, D. W. M., D. & R. G. R. R., Denver.
R. S. Riley, Loco. Foreman, Can. Pac. Ry., Winnipeg, Man.
H. A. Huddleston, Trav. Eng., D. & R. G. R. R., Salida, Colo.
V. B. Lang, M. M., Chicago & Alton R. R., Bloomington, Ill.
J. D. Harris, M. M., Penna. Co., Crestline, Ohio.
D. Cunningham, Supt. Nor. Div., C., B. & Q. R. R., La Crosse, Wis.
D. A. Sweet, Pass Engr., Ft. W. & W. Ry., Ft. Wayne, Ind.
Russell Wallace, Crerar, Adams & Co., Chicago.
A. M. Smith, Asst. Audr., C. & E. I. R. R., Chicago.
E. H. DeGroot, Jr., Trainmaster, C. & E. I. R. R., Chicago.
W. T. Putnam, Coach Foreman, C. & E. I. R. R., Chicago.
G. Fred. Collins' B. M. Jones & Co., New York.
J. C. Campbell, Natl. Tube Co., Chicago.
M. W. Hibbard, Draftsman, Chicago Junction Ry., Chicago.
David Meadows, Trav. Engr., Mich. Cent. R. R., St. Thomas, Ont.

President Hetzler: We have for discussion this afternoon the reports of two committees, the report of the committee on Revision of Rules of Interchange, and the report of the committee appointed by the Western Railway Club to report on the prevention of smoke by the various railroads entering Chicago; also a paper by Mr. John M. Taylor on "Improved Methods and Facilities for Handling Materials from, through and between Various Shops and Storehouses, and Accounting for Same."

We will first discuss the reports of the committees, taking up, to start with, the report of the committee on Revision of Rules of Interchange. The report of the committee is as follows:

Chicago, March 29, 1900.

To the Members of the Western Railway Club:

Your committee appointed to make a report on the revision of the Rules of Interchange, for the April meeting of the Western Railway Club, begs leave to submit the following:

In this report, any rule or section or note which, in the opinion of the committee, does not require revision, is not mentioned.

Page 3, Rule 3, Section 1.

Add the figures "20" and the word "and" after the word "section" on

the fourth line in the paragraph under the form of defect card, making it read "In sections 20 and 32 of rule 3, etc."

PAGE 12, RULE 3, SECTION 17.

Change limits of size of wheel seat of axles for 70,000 capacity cars from 5⅝ inches to 5½ inches; and 80,000 capacity cars from 6¼ inches to 6 inches; and 100,000 capacity cars from 6¾ inches to 6⅝ inches.

PAGE 29, RULE 5, SECTION 10.

At the end of paragraph referring to the weight charged for new journal bearings, etc., add the words "whether repaired on defect cards or not."

PAGE 31, RULE 5, SECTION 13.

Increase the price of one coupler complete from $7.50 to $8.00. One coupler body from $4.50 to $5.00. After the word malleable add the words "or wrought," making the section read, "One coupler complete, $8.00; one coupler body, $5.00; other individual parts; malleable or wrought, 3½ cents per pound; other individual parts, steel, 4½ cents per pound."

PAGES 32, 33, 34, 35 and 36, RULE 5, SECTION 19.

The word "renewed" and the word "replaced" seem to be used in the same connection for different items.

The attention of the Club is called to this, as it seems to need revising.

PAGE 36, RULE 5, SECTION 19.

Add at the end of the table "truck transoms, 2, wood, replaced, same truck, 12 hours. Charge for labor $2.40. Same charge for both ordinary and refrigerator cars."

PAGE 36, RULE 5, SECTION 21.

Add to the table "Angle cock repaired, 20 cents." "Check valve ground in, 5 cents."

PAGE 38, RULE 5, SECTION 22.

Add the words "and under 80,000" in the last paragraph on the bottom of the page after 60,000, and cut out the two words "or over" in first line, making the paragraph read, "When cars of 60,000 pounds capacity and under 80,000 pounds capacity and so stenciled, have trucks with journals 4 inches or over in diameter when new, $25.00 per car shall be added to the figures as given above for the alues of car bodies," and add a new paragraph, reading as follows:

"When cars of 80,000 pounds capacity or over, and so stenciled, have trucks with journals 5 inches or over in diameter when new, $40.00 per car shall be added to the figures as given above for the values of car bodies."

PAGE 40, RULE 5, SECTION 26.

On the fourth line, between the words "construction, and broken," insert the words "worn out brasses." On the fifth line, between the words "bars and column," insert the words "draft timber bolts." Simply adding to the section "worn out brasses and draft timber bolts" as such items for which switching roads may bill direct against car owners for defects made and repaired by them.

PAGE 41, RULE 6, SECTION 3.

Add a note after this section, reading "Railroad companies having their car

repairs pooled shall accept repaired trucks at any point within the territory of the pool."

R. D. Smith, Chairman.
Jos. Buker,
J. J. Hennessey,
C. M. Mileham,
P. H. Peck,
Committee.

President Hetzler: In order that this work may be handled thoroughly and quickly, it has been deemed advisable to have the Secretary call the sections of the Rules of Interchange as they appear in the book of rules, in this way enabling members to recommend such corrections and changes as they may desire. I will ask the Secretary to call off the sections.

The Secretary called off the rules by number and section, and as changes were suggested they were taken up as follows:

Rule 3, Section 1.

Mr. R. D. Smith: The committee has a recommendation to make as follows:

Rule 3, Section 1: "Add the figures '20' and the word 'and,' after the word 'section' on the fourth line in the paragraph under the form of 'Defect Card,' making it read, 'in Sections 20 and 32 of Rule 3, etc."

Section 20 refers to trucks, while Section 32 refers to body of cars, and if it is proper to have one, it is certainly proper to have the other, and it must have been an oversight when it was omitted last year from the rules.

President Hetzler: You have heard the corrections proposed by the committee. What is your pleasure, gentlemen?

On motion the recommendations of the committee were adopted.

Mr. F. H. Stark (C. L. & W. Ry.): In Rule 3, Section 14, it says "chipped flanged, if chipped is on throat side of flange, and exceeds 1½ inches in length and ½ inch in width."

As I understand it, if it exceeds either, it condemns the wheel; but here it would intimate that if it exceeds the inch and a half and not the half inch, or both limits, it would not be condemned. I would like a little information on that.

President Hetzler: Mr. Rhodes, will you interpret the rule as you understand it?

Mr. G. W. Rhodes (B. & M. R. R.): I should say, Mr. Chairman, that the meaning, between the commas, is that if it exceeds 1½ inches in length and ½ inch in width, that would condemn it. I do not know whether any of the members present have seen a chipped flange that was, say, 2 inches, or 2½ inches in length that did not exceed ½ inch in width. I do not know what combinations might come up there, but I should think if it was longer than 1½ inches, it would be wider than ½ inch.

Mr. P. H. Peck (C. & W. I. R. R.): Oftentimes the flange is chipped on the throat side more than 1½ inches, probably by being too thick, and being on the throat side of the flange, it condemns it, but this is not the case if chipped on the outside. There may be several chips on the outside of the flange where they go through frogs, or something like that; it chips the outside, but not the throat side. That is the reason; but before you condemn a wheel, it has got to be chipped on the throat side; the outside does not count in matters of that kind.

President Hetzler: Mr. Stark, is the explanation satisfactory?

Mr. Stark: It appears to me it ought to read, "1½ inches in length, *or* ½ inch in width." We have had cases where it exceeded the ½ inch, but not the 1½ inches, and the joint inspector took the position that if it exceeded either it condemned the wheel, while I believe that if a wheel was found chipped to exceed ½ inch in width, and not the 1½ inch in length, that it would be considered condemed. If the word "and" were changed to "or," it would simplify it.

President Hetzler: Do you make a motion to that effect?

Mr. Smith: It seems to me that would be drawing the line rather fine. I was a member of the commiee on the changing of the rules last year, when this question was threshed over pretty thoroughly. It seems to me that as the rule reads now it is quite plain, and I believe that we should pass by the section.

Rule 3, Section 17.

Mr. Smith: The committee has a change to suggest in Section 17, Rule 3: "Change limits of size of wheel seat of axles for 70,000 capacity cars from 5⅝ inches to 5½ inches; and 80,000 capacity cars from 6¼ inches to 6 inches; and 100,000 capacitty cars from 6¾ inches to 6⅝ inches."

This makes a more uniform difference in the limits of wheel seats

of axles for the different capacities of cars. The reason for suggesting this change is that under the present rules axles for 80,000 pound cars can only be reduced 1/8 inch in the diameter of the wheel fit, while 1/4 inch for 40,000 capacity cars and 3/8 inch for 60,000 capacity cars is allowed. It is thought that it would be perfectly safe and proper to make the minimum for the 70,000 capacitp axles 5 1/2 inches, and foO the 80,000 capacity axles 6 inches, and for the 100,000 capacity axles 6 5/8 inches.

A motion that the recommendations of the committee be adopted was seconded and carried.

Rule 3, Section 38.

Mr. Stark: There are some roads that are equipping 80,000 capacity cars with automatic couplers, having a 6 inch by 6 inch shank. I believe it is quite generally conceded that the present standard dimensions are not strong enough under these heavy capacity cars. I would like to see the following rule added to take the place of Section 38: "Cars intended to be equipped with M. C. B. couplers with 6 inch by 6 inch shank, and so stenciled, if found with M. C. B. couplers having 5 inch by 5 inch shank, the delivering road to be responsible."

This would necessitate adding one more section. I believe it would be manifestly wrong for a road to substitute a coupler with 5 inch by 5 inch shank in lieu of a coupler with 6 inch by 6 inch shank. I believe that it is necessary to increase the shank of the coupler on account of the increased load. There are a great many cars being built just now with a coupler with 6 inch by 6 inch shank, and the question arises whether an M. C. B. coupler would be the proper repairs. I believe this Club should at least give an expression of the subject.

President Hetzler: Will you kindly read the proposed rule again?

Mr. Stark: To Rule 3 added Section 38, "Cars intended to be equipped with M. C. B. couplers with 6 by 6 shank, and so stenciled, if found with M. C. B. couplers, with 5 by 5 shank, the delivering road to be responsible."

I would like to make a motion to that effect.

Motion was seconded.

Mr. Peck: I do not know that the M. C. B. Association has adopted such a coupler, and I think it would be out of order to re-

port that at this meeting. We might ask them to recommend it, but we should not report it as our recommendation, because the limit from 33 to 34½ inches would cover all that. It is a factor of safety which I think is all right, but I think we are premature in our doing this. It would result in wrong repairs, that is, something that could not be found out, and wrong inspection probably, unless they measure it by the drawbar, and I think unless the Master Car Builders' Association adopt a certain width, that we ought not to recommend anything otherwise than what the M. C. B. Association adopts.

The Secretary: I would like to say that the committee of the M. C. B. Association on M. C. B. couplers has that subject under consideration—the increase of the size of the shank.

Mr. Smith: It seems to me that what Mr. Peck says is directly in line on this point, and that it would be wrong for us to recommend a change in the rules. I believe there is a committee on this subject now which is considering the necessity of increasing the size of the shank of the M. C. B. coupler, and I do not believe it would be proper for us to pass this resolution, as it will take care of itself through this committee. I hope the motion will not prevail.

President Hetzler: Any further remarks? If not, all those in favor of the motion as made, will please manifest by saying aye; contrary, no.

The motion was declared lost.

Rule 5, Section 10:

Mr. Smith: Your committee has a correction to suggest.

Rule 5, Section 10: "At the end of the paragraph referring to the weight charged for new journal bearings, etc., add the words 'whether repaired on defect cards or not.'"

This change is recommended so that there will be an arbitrary scrap credit for brasses of all kinds.

On motion the recommendation of the committee was adopted.

Rule 5, Section 13:

Mr. Smith: The committee has a recommendation to make on Section 13, Rule 5.

"Increase the price of one coupler, complete, from $7.50 to $8.00. One coupler body, from $4.50 to $5.00. After the word 'malleable' add the words 'or wrought,' making the section read, 'One coupler, complete, $8.00; one coupler body, $5.00; other individual parts,

malleable or wrought, 3½ cents per pound; other individual parts, steel, 4½ cents per pound.'"

On motion of Mr. Peck, the recommendation of the committee was adopted.

Rule 5, Section 19:

Mr. Smith: The committee has some suggestions to make. On pages 32, 33, 34, 35 and 36, Rule 5, Section 19, "the word 'renewed' and the word 'replaced' seem to be used in the same connection for different items." The attention of the Club is called to this, as it seems to need revising.

I should say that the word "renew" means to restore a piece to a former state, or to put in good condition after decay or impairment; and that the word "replace" means to restore a piece or to put back to a former place or position, or to put in a new or different place; or, in other words, "renew" refers to a former condition, while "replace" refers to a former position. I believe that the Arbitration Committee can do some little work on that and help us out a little.

President Hetzler: What is your pleasure, gentlemen?

Prof. Wm. F. M. Goss (Purdue University): Does the committee make a definite recommendation?

President Hetzler: This is, I understand, not a recommendation, but a suggestion.

Mr. Smith: The committee call the attention of the Club to the use of the words. Both are used in the same connection, and do not seem to be used properly. I believe that there have been different parts added to this section from time to time, and some committees have reported to renew while others have reported to replace.

Mr. S. P. Bush (C., M. & St. P. Ry.): I move that the Club recommend that the two words be used in the rules in accordance with their proper grammatical use. That each be used in its proper place.

The motion was carried.

Mr. Smith: Your committee would recommend an addition to Section 19, Rule 5, as follows:

"Add at the end of the table, 'truck transoms, two, wood, replaced, same truck, 12 hours. Charge for labor, $2.40. Same charge for both ordinary and refrigerator cars."

The reason for making this recommendation is that it is frequently the case that two truck transoms are removed from the same truck, and under the present rules twenty hours can be charged, when it wi

be generally admitted that two hours additional for replacing the other transoms are sufficient.

On motion, the recommendation of the committee was adopted.

Rule 5, Section 21 :

Mr. Smith : Your committee would recommend to add to the table in Section 21, Rule 5, "Angle cock repaired, 20 cents." "Check valve ground in, 5 cents."

These changes are recommended, as it is shown the work is frequently done, and the prices are about correct.

Mr. Rhodes : I would like to ask the chairman of the committee whether we will then have angle cocks renewed at 5 cents and angle cocks repaired at 20 cents—will that be the result?

Mr. Smith : No ; this means angle cock ground in.

Mr. Rhodes : You charge for the angle cock ?

Mr. Smith : The recommendation is for the labor only for repairing an angle cock that is already on the car.

On motion the recommendation of the committee was adopted.

Rule 5, Section 22 :

Mr. Smith : Your committee would recommend to add in the last paragraph at the bottom of page 38 the words "and under 80,000" after 60,000, and cut out the two words "or over" in first line, making the paragraph read, "When cars of 60,000 and under 80,000 pounds capacity, and so stenciled, have trucks with journals 4 inches or over in diameter when new, $25.00 per car shall be added to the figures as given above for the values of car bodies."

And as a new paragraph, reading as follows :

"When cars of 80,000 pounds capacity or over, and so stenciled, have trucks with journals 5 inches or over in diameter, when new, $40.00 per car shall be added to the figures as given above for the values of car bodies."

On motion of Prof. Goss the recommendations of the committee were adopted.

Rule 5, Section 26 :

Mr. Smith : Rule 5, Section 26, the committee would recommend as follows, on page 40 :

"On the fourth line, between the words 'construction and broken,' insert the words 'worn-out brasses.' On the fifth line, between the words 'bars and column,' insert the words 'draft timber bolts,' simply adding to the section, 'worn-out brasses and draft timber

bolts,' as such items for which switching roads may bill direct against car owners for defects made and repaired by them."

Mr. Peck: I would make the suggestion (I am on that committee) that "follower plates" be added. On a great many lines running into Chicago the followers are in very bad condition, and often pretty nearly broken in two, but show no rough usage. I would move that follower plates be added in this section. I do not think it is unfair nor unjust.

President Hetzler: I think it would be better to pass upon the recommendation of the committee first, and afterward consider that as an amendment to it.

Mr. Smith: I had hoped somebody else would get after my friend Mr. Peck about this matter, as we have disagreed on this point before, because his road is a switching road. They handle the draft rigging pretty roughly, and as they have no cars of their own to interchange, I think when they break a follower plate they ought to pay for it.

Mr. Peck: I differ from Mr. Smith very materially, whether on a switch road or not. The road with which Mr. Smith is connected, and many of the other roads that deliver us cars, push them in the yards and knock them off their centers, and they leave them there without knowing anything about it. I have made bills against them for knocking cars off the centers. The same is true with follower plates; they break them in the same way. I think if the follower plate is all right when delivered, that the switching load will not damage it any more than the C., B. & Q., or any other of the roads. I have seen many that were picked up, and on examining them have found that they were badly damaged or cracked before, and I do not think it is unfair to ask that follower plates be included in this section.

Mr. Bush: I move the adoption of the recommendation of the committee. Seconded.

President Hetzler: The motion has been seconded. All those in favor of the recommendation of the committee manifest by saying aye. Carried.

Rule 6, Section 3:

Mr. Smith: On page 41, Rule 6, Section 3, add a note after this section, reading: "Railroad companies having their car repairs pooled shall accept repaired trucks at any point within the territory of the pool."

On motion, the recommendation of the committee was adopted.

Mr. Smith: I would make the motion that the report of the committee as amended be adopted and the committee discharged. Carried.

The Secretary: The rules as amended are given on pages 367 and 368 of these Proceedings, the changes being in italics.

REPORT ON PREVENTION OF SMOKE.

President Hetzler: We will next take up the report of the committee appointed to investigate the prevention of smoke by the various railroads entering Chicago.

Mr. G. R. Henderson, chairman, then read the following report:

Report of Committee

Appointed by Western Railway Club, October, 1899, to Investigate and Report Upon the Matter of Smoke Prevention by the Various Railroads Entering Chicago.

Mr. President and Gentlemen :

At the October, 1899, meeting of the Western Railway Club you appointed a committee to investigate and report upon what is now being done in the matter of smoke prevention by the various railroads entering Chicago, and what lines should be followed to accomplish the results sought after. Your committee has found this to be rather a difficult undertaking, especially the last portion of the instructions, as there seems to be quite a diversity of opinion among the different motive power officers as to the value and merit of the various devices advocated for the purpose of preventing smoke. Some arrangements are endorsed heartily by certain parties and are pronounced worthless by others, while it is positively known that possibly the best example of smokeless firing is given by a road that uses no device but the brick arch.

This being the case, your committee finds it difficult to make any definite recommendations as to the feasibility of mechanical contrivances, some of them being so preposterous and *un-mechanical* that they could hardly be seriously considered.

In order to get a complete list of the different methods adopted by the various roads entering this city, the following questions were asked of the motive power departments :

First : What devices or appliances are you using to prevent smoke on your passenger, freight and shifting engines running into Chicago? Please give us full particulars, with blue prints illustrating said appliances ; also statement of kind of fuel used and any other data.

Second : What results are obtained with such devices as you may have in use, and what tests have you made with such appliances, and with what success has this been attended? If not successful, can you say why?

Third : What policy do you adopt when building new locomotives that will run into Chicago, in order to better prevent the smoke nuisance in the way of special devices applied to engines, or particular size or arrangement of firebox or flues?

Fourth : Please furnish a list of coals which you are using in this locality, with analyses and relative steaming and smoking values.

We do not expect that these points can be answered absolutely and accurately. We think that an abstract giving your views on the same will be of value.

Fifth: How do you look upon the efficiency of various firemen in connection with the smoke prevention subject, and what instructions or orders have you issued to your men in regard to this subject?

Many of the replies to this circular were very full and complete, with drawings. With the exception of the brick arch, which is quite generally used, the air injector (or jet of air forced into the firebox through openings through the water space) seems to be the favorite method of smoke reduction, though some claim that lt is more of a smoke *diluter* than a smoke *consumer*. Most roads using these air je s report s· ccessful results when they are properly manipulated, and particularly when used in connection with a brick arch. They are not claimed, however, to produce economic l results, partly due, no doubt, to the fact that the air is more or less cold when it enters the firebox. There are some suggestions for heating the air before it is forced into the firebox, but most of the methods suggested seem to your committee to be impracticable.

Several roads reported that their trials of these air jets had been unsuccessful, and especially when used without a brick arch.

One superintendent of motive power says:

"I have not said as much in respect to the brick arch as I really think it deserves. I think that drawing air through the fire instead of over it, and having a brick arch that will equalize the heat of the gases and make a combustion chamber behind it, will do a great deal to prevent smoke and produce a more nearly complete combustion of the coal."

In speaking of the steam jets, he remarks that he considers:

"That all these devices are more or less copies of the old idea known as Clark's steam jet, although having a number of other trade names. They are all effective in reducing smoke, although this is done, I believe, at the expense of economy in coal consumption. The efficiency of these devices also depends upon the intelligence with which the firemen handle them, and it may be truly said that an effective smoke prevention is very largely in the hands of the fireman."

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"Authorities on combustion seem to agree that steam is not a good thing to introduce in the fire, and that in introducing air, as under an induced jet, there is no real combination. unless the air is heated up to about the temperature of the gases in the firebox."

In regard to the new engines built for service in and around Chicago, practically all the roads are equipping these engines with one or more of these devices, mostly consisting of brick arches and air jets. In addition, some of the roads are providing boilers with large grate areas and heating surfaces, the grates in some cases being as wide as six feet. Of course, only certain types of engines permit this arrangement, and its use is limited. A firebox over ten feet in length is handled with difficulty, so that there is practically a limit to the size of grate, unless a special construction like the Wooten is gone into, and this type has some disadvantages.

The smoking of coals depends largely upon their composition. Those high in fixed carbon and low in volatile matter, like the Pocahontas, of southwestern Vir-

ginia, will produce little smoke. The Pocahontas is, in fact, advertised as a smokeless coal. It contains from 75 to 80 per cent of fixed carbon, and about 20 per cent of volatile matter. The Illinois coals have about half as much fixed carbon and twice as much volatile matter. It is not always the fact, however, that the best coal for heating is the freest from smoke. Coal in the fine or slack condition will generally be more difficult to control in this direction than if broken in proper sized lumps, because there is less opportunity for the air to pass through the grates.

The railroads entering Chicago use a great variety of coals. Those roads running east and south naturally draw from a different territory than those extending to the west and northwest. One road reports drawing altogether from over one hundred mines, and in times of a scarcity, the inferior grades are of necessity bought for consumption in this neighborhood. Some roads in the east have the advantage of coke and anthracite where the prices are as low or perhaps lower than bituminous coal, but they would be practically prohibitive for railroads here, even more so than for factories, as many of the former burn upward of 1,000,000 tons a year. Some of the eastern roads advise that they have difficulty, and, in fact, cannot obtain a sufficient quantity of coke for their needs. Under these conditions the outlook for coke fuel in the west is not very encouraging, until some new sources of coke supply are available at low cost.

The importance of careful firing is recognized by all the roads reporting to your committee, the general sentiment obtaining that a good fireman without a special device is productive of better results than any of these devices poorly managed.

Nearly all of the roads have not only issued concise instructions to their engineers and firemen from time to time, but it is a common practice to select expert firemen and employ them to travel on the engines and explain and illustrate the proper methods of firing to those who are less expert in the matter. Nor can all be done by the fireman,—the engineer must also assist, both by handling the engine in an intelligent manner and by communicating constantly with the fireman. In fact, to produce the best results, there must be a hearty co-operation between those concerned. The engineer should be quick to appreciate the effects of his manipulations on the fire and regulate the "cut-off" and throttle as far as possible to produce the best results, keeping his fireman informed of his intended movements. The fireman should be on the alert to take every advantage of the physical conditions of the road or any cessation in the work and should fire lightly and regularly,—not five or six shovelfuls with a rest in between, but with one shovelful at a time and the door closed gradually—that is, cracked for a few seconds until there is sufficient air to consume the fresh distillates and then closed completely, except where a damper or register in the door is employed. The gauge should be scrutinized every few minutes and the supply of air regulated principally by the dampers; the blower and smoke consumer must be ready for instant use on the closing of the throttle, as this is the time that the greatest volume of smoke is likely to be produced.

In order to effect these results, however, the motive power officials must perform their part. In European countries it is considered dangerous to make a man on an engine too comfortable, as such an arrangement may make him careless in

his work ; the theory obtaining on this side of the Atlantic, however, is that the more comfortably a man is installed, the better can and will he attend to his duties. With this end in view, fire doors should be at a convenient height and of a suitable size, the steam gauge should be in *comfortable* view, both by day and night, the blower or smoke consumer valves should be quick acting and convenient of access from the foot plate, and water gauges should be arranged for constant observation. Sloping sides to the tank, and coal properly broken up, will also facilitate the work so that the man with the shovel can give his complete attention to firing and other necessary duties. Many engines are so inconveniently arranged in the cab that it is almost preposterous to expect and ask good results, and a ride on the engine will often show the unintelligent manner in which the fittings have been placed.

The brick arch should be properly located, and if smoke consumers in the form of air or steam jets are determined upon, they should be maintained in good condition. Intelligent instructions should be given to all enginemen, and they should be taught and expected to take an interest in the results of their work. Individual fuel reports will show the economy of the different crews, on similar runs, and may be considered some index to the smoke consumption obtained. In order to illustrate the methods adopted by some of the larger roads entering this city, a few extracts from their circulars to engineers and firemen are here reproduced. The Northwestern circular was issued in February, 1895. While this was largely in the interest of fuel economy, it contained this pertinent clause :

"Firemen should always be careful not to put in too much coal at a time, but should fire evenly and regularly. It is not good practice for any fireman (nor is he a good fireman that will do it) to put in five or six scoops at a time, and then look at the volume of black smoke that rolls out of the stack. Black smoke is coal, and whenever this is seen coming from the stack, it means that the fireman that does it, is pretty well down to the bottom of the list on coal consumption."

The instructions issued by the Grand Trunk include the following :

"Firemen must fire lightly and avoid heavy firing, and the fire door must be closed after each shovelful when the locomotive is working."

"Firemen must anticipate their work and supply the coal to the fire accordingly before reaching a regular shutting off point, put in a slightly heavier fire long before shutting off, so that the fuel will begin to burn and not give off black smoke when the supply of air is checked. If a stop is made at any place where green coal is on the fire, apply the blower before the steam is shut off, then as soon as the throttle is closed, open the door slightly on the latch, and reduce the blower throttle sufficiently to prevent the black smoke and waste of steam through the pops."

"In reference to the proper method for the distribution of the bituminous coal over the locomotive grate surface, that we may obtain the most efficient results and avoid the forming of wasteful gases which issue from the stack when black smoke is produced, a set of rules cannot be given. However, skillful firemen will note, immediately upon opening the furnace door, where the fire is at the least depth on the grates and burns with the most incandescent flame, that fresh fuel scattered over such a portion of the grates will give the best results."

The Michigan Central notice is as follows:

"The ordinance of the city of Chicago requires us to fire our locomotives without making any black smoke. It is imperative that we insist that all road and switch engines running in the limits of the city of Chicago, be fired on the 'one shovelful system,' and any failure to do so will result in the discipline of the employe at fault. We know that black smoke can be prevented by careful firing, and demand that it be done."

Besides, all enginemen are presented with Sinclair's "Burning Soft Coal without Smoke" which treats of methods in use on the B., C. R. & N. Railway and which are practically the same as those already suggested in the foregoing report.

In 1892 the Illinois Central issued this notice to enginemen:

"All engines running into Chicago are to be equipped with smoke consumers, and it is very important that enginemen use them whenever necessary for the prevention of black smoke within the city limits of Chicago.

"Those who do not fully understand the working of this device will call upon the master mechanic or inspector, who will give them the necessary information.

"It is the duty of enginemen to see that smoke consumers are used and kept in proper condition, and they will be held personally responsible for the condition and operation of the same, as well as any violation of the 'Smoke Ordinance.'"

Other circulars and bulletins of this nature have been issued from time to time by the various railways.

In connection with this subject, it should be borne in mind that many of the larger roads running into Chicago use from 500 to 700 tons of coal per day, and the difficulty of obtaining at all times the desired quality of fuel can readily be appreciated.

Then, of necessity, new firemen must occasionally be employed, and as good results can hardly be expected from inexperienced men.

The question naturally arises: How does the smoke nuisance and its treatment in Chicago compare with other cities?

The statutes of the city of Cincinnati are practically identical with those of Chicago, yet we find that few roads entering that city use any special device for reducing the amount of smoke, or provide any definite arrangements on new locomotives. The firemen, however, are instructed carefully, and good results are reported.

One road running into Cincinnati and St. Louis advises that "it believes with an efficient fireman more can be accomplished than with any device it has tried." Instructions to its firemen are to fire not more than two shovelfuls, preferably one, and to leave the door partly open for a few seconds after putting in fresh fire.

Another road reports as follows:

"We have thus far been able to demonstrate to the smoke inspectors at Cincinnati and Indianapolis that the average locomotive can be fired with one shovelful of coal in the city limits, and where this is done it has satisfied them that we are accomplishing everything in our power."

And again, from a road running into St. Louis:

"In reply, desire to advise that we have tried a number of the so-called smoke preventing devices upon our engines running into the union stations at St. Louis and Kansas City, but with no appreciable results as far as regards diminishing the smoke nuisance. Our best success in the abatement of smoke has been accomplished by the exercise of care on the part of the enginemen in the handling and firing of the engines inside the city limits, and the further exercise of special caution while in the train shed at union station, St. Louis. By such methods we have reduced the smoke nuisance to a minimum. In my opinion, careful firing and handling of the engine is the most efficient smoke preventive."

As far, then, as the western cities are concerned, it seems that more attention is given to the subject, both by the city authorities and by the railway officials, and that better results are reached in Chicago than elsewhere. Furthermore, motive power men in Chicago seem willing and anxious to solve the problem of better combustion and smoke prevention, and at the present time quite a number of interesting experiments on a practical scale are under way.

In regard to the eastern cities, Philadelphia has no law on the subject, probably due to the fact that anthracite coal is the predominating fuel in that locality. Many of the locomotives, however, burn bituminous coal.

New York and Boston both have ordinances requiring furnaces to consume their own smoke; the principal roads entering these cities depend largely upon the brick arch and careful firemen, and Sinclair's book, already mentioned, is distributed and traveling firemen employed to instruct the men.

The proximity of the anthracite coal fields offers a comparatively cheap smokeless fuel to eastern roads, and yet much soft coal is used in that locality. Coke is also used, to a limited extent, and this is, of course, smokeless. The Boston & Maine Railroad, which has experimented largely with this fuel, report as follows:

"Coke, as we receive it, is the most satisfactory solution of the smoke problem of anything we have yet seen. The absence of a larger supply of this fuel at the present time is the only reason for its not being used on a greater number of our engines. Provided coke can be obtained at a reasonable price and of suitable quality, and with engines properly proportioned for burning same, I would place it first, as the best and easiest solution of the smoke problem.

"In the economical burning of bituminous coal and prevention of smoke, we look upon the personal equation of our engineers and firemen as most important, and we have been and are continually laboring to raise their standard and educate them on all points connected with this matter. We have men engaged unremittingly in instructing our enginemen by classes, and also our firemen, and we are prepared to say that we think the efforts well rewarded and the results material, and commend it to others for regular diet who have not acted similarly."

In conclusion, your committee begs to state that it believes it has covered the subject assigned to it, in as full a way as is possible with the data at hand, and that it has pointed out what are the most promising lines to follow in order to accomplish the desired end.

The blue prints and other information forwarded to your committee may be examined by those interested, upon application to the chairman of the committee.

G. R. Henderson, Chairman.
R. A. Smart,
R. D. Smith,
J. C. McMynn,
J. W. Luttrell,
Committee.

Chicago, March 21, 1900.

President Hetzler: You have heard the report of the committee, gentlemen; what is your pleasure?

Moved by Mr. Peck that the report be adopted. Seconded.

Mr. Henderson: We have the pleasure of having with us Dr. Reynolds and Mr. Schubert. I think they inaugurated this subject last fall, and I think we all would be glad to hear them make some remarks.

Dr. Arthur R. Reynolds (Commissioner of Health, Chicago): Mr. Chairman, and members of the Club, I want to express my appreciation of the effort of this committee. I believe that it has done an admirable work, and believe it has furthered very materially the question of smoke prevention upon engines. I had hoped that they might, perhaps, discuss the coking of Illinois coal; however, I presume that question is still in the formative state.

I had hoped for an opinion from this committee, too, on the question of coal, that is, what grade of coal the railroads ought to use; whether it is possible to burn the cheap Illinois fuel, and do it without making smoke. I cannot discuss, of course, the mechanical part of the paper, but, on the whole, I think the subject has been admirably treated, and I feel very grateful indeed to the Club for its efforts.

Mr. John C. Schubert (Chief Smoke Inspector): I believe the discussion that was brought out here last October is going to result in some good. The committee has covered nearly every point that can be covered, as far as we have gotten. I believe, if you will allow the suggestion, that you allow the committee on smoke nuisance to live a little longer, it will result in more good. The reason for asking that is, that about three months ago I paid a visit to Pittsburg and saw a locomotive in operation—a locomotive that did admirable work. The plan was something entirely different from anything tried in this

part of the country. I tried very hard to get the inventor to come to Chicago and equip a locomotive and show it to the railroad men here. The locomotive equipped at Pittsburg is owned by the B. & O. road, and is used for switching passenger coaches in the depot there. The construction is very simple, and the statement was made, and I believe it can be verified (at least some parts of it I saw myself), that there were no cinders thrown from the locomotive to speak of; in fact, I noticed none at all; the fire required cleaning just once every twenty-four hours, and the claim was made that the locomotive consumed one and one-half tons of coal less a day than before it was equipped.

I wrote last week to the inventor, Mr. Hughes, asking him to be here and attend this meeting and tell you something about it, or make some arrangement by which it can be tried; either brought here, or one equipped in this town. I believe the thing is started in the right direction. I believe a great deal of smoke could be prevented by the use of this device. Still, that would be a thing for those gentlemen who are more conversant with a locomotive to know whether it was practicable or not. From what I saw there I was very much pleased with it. I have the blue print, which I will be glad to turn over to this committee to use, if it is desired, and they could go on and investigate this matter.

I also want to say that about six months ago I was called upon by Mr. Westlake, the old inventor Westlake, formerly of the Adams & Westlake Company. He told me of a device that he was perfecting then, in Brooklyn, which he believed would do away with all smoke on either a locomotive or on any device. The idea was to feed coal dust or ground coal through a hopper on to the fire. At that time it struck me the idea was right; now I am positive, because we have today, within fifteen miles of Chicago, a furnace equipped with a hopper somewhat similar to Mr. Westlake's, the Schwartzkopf device, that is being used in England, Germany and France. I saw one last Thursday afternoon; I visited the factory and saw them feed the ground coal in this way. They simply took a piece of brick, threw it into the combustion chamber and began to feed this coal dust from a hopper, and the flame that came was just like gas, absolutely smokeless. It could be made to smoke if you wanted it to smoke, but properly operated, there was no more smoke than there would be from a cigar that was not being drawn too strongly. The contriv-

ance was a simple one, can be seen at any time, and I think it will pay you, gentlemen, to visit this plant to see it in operation; it is something that is radically new, and I believe will solve the question of coal when you get a plant that will grind up the coal. The difficulty they now find is that it costs them about two dollars to grind this coal; but it can be done, if properly equipped, for about twenty cents a ton. When that is once in operation, I do not think we will have any more trouble from smoke.

These gentlemen have not tried it on a locomotive, but it is very similar to Mr. Westlake's device, and Mr. Westlake claims for his device that it absolutely controls all smoke on the locomotive. Those are two things I believe your committee ought to investigate. They are building a station in Brooklyn which will be completed the first of May, and it will then be seen whether the work expected from it will be accomplished. For that reason I suggest that your committee, which has done a great deal, I think, to help the city of Chicago in quieting the dissatisfaction there is about smoke from locomotives, should continue its investigations. I think a great deal of good will result. I think you have started in in the right direction, and I do not believe there has been near so much smoke as there was last October. Occasionally the boys get away from us, but as a rule we get very few reports where there is dense smoke or careless firing.

Mr. Rhodes: It seems to me that the information just given is useful and interesting, and that the committee might do some more work, in place of dismissing them.

Those of us who have had charge of planing mills know that when a fire starts in a planing mill, the impalpable dust that is in there ignites at once and quickly becomes a sheet of flame. Those of us who have been connected with the coal busines know that there is nothing more dangerous on a coal tipple than a spark; the impalpable dust throughout the coal tipple, if any fire takes place, all becomes ablaze at once; and you generally find, if you go on coal tipples, frequent notices that no matches are allowed to be struck, and no smoking is allowed under any condition. I should be very much interested in hearing the committee's investigation of a heating device or plant that contemplates the use of this coal dust for fuel.

Mr. Peck: I agree with Mr. Rhodes, for the reason that while they get a great many devices on stationary engines or marine

engines, where the draft is the same for twenty-four hours, thirty-six hours, or whatever time they are working, on a locomotive it is changed every time the engineer moves the throttle or changes the lever. A soft coal burning engine may be consuming smoke entirely as it goes along, but the engineer may be blocked, or may come to a semaphore, the steam is shut off, and the consequence is, we will have smoke—we can not avoid it for the time being. If there is any such device for a locomotive as for the boiler flue plants, it might be a good thing. I have never seen it. I have never seen a boiler flue equipped in that way, and I think it is the same way with the draft end consuming the coal. Probably at the place in Pittsburg that Mr. Schubert speaks of, they have different coal. We use an Illinois coal and we can not coke that, and we could not well bring other kinds of coal here and coke it. The coal here used is generally a mine run coal, and if there are strikes, or any trouble, we have to use whatever we can get; we try to do the best we can, and if there is anything more that we can do, we will be glad to do it. I told Mr. Schubert that I would try any experiment that he chose to bring before us, We have spent a great many hundred dollars so far, and I told him we would spend a few more if we could do some good.

Mr. T. S. Reilly (*Railway and Engineering Review*) : I was in Pittsburg, two or three weeks ago, and saw the device that Mr. Schubert speaks of, but I did not see the switching engine to which it had been applied. They had it on a stationary boiler in the shop, and I guess you have all seen, in some of the journals, a description of the device, which consists of a perforated casting about eight inches high, resting against the sheet at its top, and about four inches away from the sheet at the bottom, which rests upon the grates, the plates extending all around the box, there being suitable piping to throw jets of air or steam through the perforations out into the body of the flame. I did not meet Mr. Hughes, but went over to the shop where the boiler was, and on the way noticed that the black smoke was pouring out of the stack. I went in and talked to the fireman about it. He said, "Oh, the steam jet is not on," went over and turned on the steam jet and said, "Now, look at it." It did the work as soon as the steam jet was running; it kept down the smoke, but I did not see there was any advantage gained over the jet device that we have which is placed in the throat sheet water leg. We shut off the jet and put it on several

times, and the smoke would come or go, according as that jet was used or not. I do not know whether they have jets in the switch engine, but I supposed they had, as it appeared to be necessary in order to make the device work. This boiler, I will say, is forced more than it should have been ; they had to force it in order to get more horse power out of it than it was designed to furnish. I do not believe the thing is going to be a great success, because it is pretty well settled that one of the main things in solving the question of smokeless soft coal burning in the locomotive is to increase the grate area, and this device decreases it. It will cut off about four inches on the inner side of the box along each side and in front and back the same, so that there are several square feet of grate area cut out, which, of course, means that you must burn the coal at so much higher a rate, and in a locomotive where you are burning at too high a rate I do not see where you are going to gain anything. Of course you can check your smoke down by using a jet, but I do not see that you are gaining very much out of the device. I do not see that we shall be enabled to derive any more, if as many, benefits from this device than is obtained at present from other forms of jet devices, especially since the device in question decreases the grate area, so desirable to have.

President Hetzler: Mr. Peck's motion as made and seconded is, that the report of the committee be accepted and the committee discharged. If there are no further remarks, all those in favor of the motion will manifest by saying aye.

The Chair being in doubt, a rising vote was taken, and the motion declared lost.

A motion that the report of the committee be accepted and the committee continued was seconded.

Mr. Henderson : I would like to file an objection to that. The committee has had considerable labor in this, and if you want the work continued I think it would be better to appoint another committee. To have the same work turned back is rather discouraging to a committee. I think we have all been in that boat before where we have heard committees report and then have tried to refer the work back to them again. I think if you desire the work to be continued it would be better to appoint a new committee.

Mr. Ira C. Hubbell (K. C., P. & G. R. R.) : I understand the Club highly appreciates the work that the committee has already

done, and the Chair is in doubt with regard to his ability to select a more able committee, and therefore we desire to continue the present one, with thanks for the work already done. (Applause.)

Mr. S. P. Bush: I would like to supplement those remarks with a word or two more, and that is, that I do not think the Club intends that the committee shall be burdened with continuous investigation, but after the remarks that we have had from the Health Commissioner and the Smoke Inspector, I think the Club would like to feel that the committee will be on the lookout for such devices as may be brought forth and developed, and that, as something comes along of that kind, they might, without much effort, be willing to report it.

The motion to continue committee was carried.

HANDLING STOREHOUSE MATERIALS.

President Hetzler: This finishes up the reports of the committees. We will next take up the subject of "Improved methods and facilities for handling materials from, through and between various shops and storehouses, and accounting for same," by Mr. John M. Taylor.

Mr. Taylor then read the following paper:

Improved Methods and Facilities for Handling Materials From, Through and Between Various Shops and Storehouses, and Accounting for Same.

By John M. Taylor

General Storekeeper, Illinois Central R. R. Co.

If, in assigning the above subject to me the initial word "improved" had been omitted, I would feel less hesitancy in presenting a paper on the subject to the members of the Western Railway Club. I am sure that the experience and observation of others are the same as mine, namely, a great many systems are in vogue, all of which have their good features.

Main Objects to be Attained.

The chief ends, however, to be attained in a well regulated storehouse, summed up, are as follows :

1. The smallest amount of money invested in material, that is possible, without delaying work. Every dollar over this means dead capital or waste of company's money.

2. The proper care of material while in store—seeing that it is not wasted or damaged.

3. To see that orders made on the storehouse are executed promptly.

4. That receipts and disbursements are looked after properly, and cost of handling kept to a minimum.

If I succeed in advancing any ideas that wili assist in bringing about the results mentioned, I will feel that my efforts have not been entirely in vain.

SHOP OR STOREHOUSE REQUISITIONS FOR MATERIAL.

Trouble Arising from Delay Handling Requisitions.

One essential feature for the successful carrying of small stock, is the proper handling of requisitions, from the time they are made by division storehouse or shop until they reach general storehouse or purchasing department. This done, and prompt shipment afterward given, insures prompt delivery, and when the fact has been demonstrated by experience that you will be given prompt delivery of material, you can take more chances on small stock, as you do not have to figure on so many days ahead.

The delay in handling of requisitions, and the uncertainty of getting material are responsible for a large per cent of the money tied up in storehouse stock.

The principal delay on some of the roads is owing the number of different offices through which requisitions have to pass for approval. For instance, requisitions go from division storehouse or shop to division superintendent, then to superintendent of motive power, from there to general storehouse, and in the event of any material that may be required sent division storehouse by purchasing department, it is re-ordered, going to superintendent of motive power, and in turn to general superintendent, to general manager, and finally to purchasing agent, and

with several days' delay that is liable to occur at different offices on account of absence of approving officers, requisitions will frequently reach purchasing department from two to four weeks after leaving maker; whereas, if requisitions are sent to general storehouse or superintendent of motive power, and then to *one* of the general officers designated for the purpose, for his approval, and by him forwarded to purchasing department, from ten days to two weeks' time is saved. The delivery of material this much earlier, means the saving of several thousand dollars on large roads in the way of being able to successfully operate on reduced stocks over what we are forced to carry, where requisitions are delayed as I have just mentioned.

Monthly Requisitions.

I heartily favor making monthly requisitions, with privilege of "specials" in case of emergency, and on roads of such size as to require several storehouses, a General storehouse from which all other shops or storehouses should be supplied thus insuring prompt delivery and smaller stocks.

It is also a money saver in the way of getting closer prices on material purchased in quantity, instead of being divided up in several small orders for same article purchased on different dates and going to as many different places.

Benefits of General Storehouse.

It is a saver of labor in all offices through which requisitions pass for approval, and especially is this so in the Purchasing agent's office who has to do with buying of material, handling of bills, etc., and in Auditing and Treasury departments in handling of vouchers and paying of them. For instance, it is better to buy fifty dozen coal scoops for General storehouse than it is to make twelve different purchases of four dozen each at different times and for different places.

Another feature in favor of the General storehouse is that of having all goods tested, or merits passed upon, before distribution is made over the line, and in the event of not coming up to the requirements, only have one return shipment to make and one set of correspondence on the subject instead of several.

The General storekeeper can save a great deal of money to the company by having surplus stock and material unserviceable on a division—made so on account of engines of certain class for which originally ordered being transferred—shifted to a point where it can be used to advantage.

We all know that obsolete material will accumulate if not watched very closely.

For convenience in making up monthly requisitions I would recommend classifying material, and from experience have found that in about forty-eight classes we can get all materials carried in stock, and not have any one of the classes so bulky but that any item under it can be easily located.

Material Classified for Use of Stock Order Books and Requisitions.

The object of this classification is uniformity in making of requisitions, and to enable one to locate any individual item quickly, which is essential in consolidating at general storehouse to arrive at requirements of entire line, and to properly group material of kind for convenience of purchasing department in placing orders.

While it would not be interesting to name each individual item appearing under any head, I will say, by way of illustration:

Class No. 1—Covers coal of different kinds (naming order in which shall appear on requisition).

Class No. 2—Illuminating and lubricating oils.

Class No. 3—Waste.

Class No. 4—Iron (naming order in which shall appear).

Class No. 5—Tool, soft and spring steel.
Class No. 6—Boiler, firebox and tank steel.
Class No. 7—Lumber.
Class No. 8—Steel rail and fastenings.
Class No. 9—Springs.
Class No. 10—Rubber goods.
Class No. 11—Wheels.
Class No. 12—Steel tire.
Class No. 13—Flues, etc.
Class No. 14—Copper, tin, lead, etc.
Class No. 15—Sheet and bar copper, brass, tin, wire, etc.
Class No. 16—Nails, brads, etc.
Class No. 17—Paints.
Class No. 18—Brushes, etc.
Class No. 19—Gray iron castings.
Class No. 20—Malleable iron castings.
Class No. 21—Steel castings.
Class No. 22—Brass castings.
Class No. 23—Axles, crank pins and piston rods.
Class No. 24—All manufactured material except forgings and bolts.
Class No. 25—Bent iron work, forgings, car and engine bolts.
Class No. 26—All air and driving brake material.
Class No. 27—Pintsch gas, steam heat and Baker heater material.
Class No. 28—Pipe, valves, cocks, and all pipe fittings.
Class No. 29—Metallic packing (different kinds).
Class No. 30—Rope, bell cord, ball wicking, mops, belting leather and kindred articles.
Class No. 31—Rivets, nuts, washers, machine, carriage and stove bolts, etc.
Class No. 32—Wood screws, can screws, bucket ears, butts, hinges
Class No. 33—Scoops, shovels, saws, hammers, axes, hatchets, etc.
Class No. 34—Injectors, lubricators, gauges, safety valves, etc.
Class No. 35—Glass (all kinds).
Class No. 36—Lamps, burners, wicks (all kinds).
Class No. 37—Chimneys, cab and lantern globes, lenses, etc.
Class No. 38—Soap, lye, washing compound, and all other kindred cleaning material.
Class No. 39—Borax, sponges, acids, alcohol and other drug supplies.
Class No. 40—Brick, lime, cement, clay, etc.
Class No. 41—Electrical supplies, fire extinguishers and supplies, etc.
Class No. 42—Automatic couplers, knuckles and attachments, etc.
Class No. 43—Coach trimmings, locks, etc.
Class No. 44—Car replacers, screw jacks, switch ropes and chains, torpedoes, fusees, flags and other train supplies.
Class No. 45—Carpet, plush and all upholstery goods.
Class No. 46—Handles, woodenware, shop machinery, hand and portable tools, etc.

CLASS NO. 47—Hoppers. urinals, washbowls, etc.

CLASS NO. 48—Miscellaneous material, not included in foregoing classification.

The classification sheets, as furnished each storehouse, show every item of material that is to appear under any class, and the order in which different items are to appear, and in preparing requisitions, class number should be written in middle of page, and items of material required immediately under, and in the order shown on classification sheet. For instance, Class No. 2 reads:

Galena car oil.
Galena engine oil.
Valve oil.
Lard oil.
Camden black oil.
Vacuum oil.
Air compressor oil.
Tallow.
Kerosene oil.
Mineral seal oil.
Signal oil.
Fuel oil.
Gasoline.
Oil, miscellaneous (not including paint oil).

Then, if it is desired to know the amount of valve oil required for the entire line, you have but to look under Class No. 2, third item, on requisition from each different shop.

Benefit of Classification to Purchasing Department.

The great benefit by this classification and "grouping," to purchasing department, is that of having the material that will likely be purchased from one firm, together. For instance, pipe fittings, etc., and so on through the list.

Advice to Div. Storehouses as to how Mat'l will be furn'd them.

Requisitions from division storehouses should be numbered consecutively, beginning new series each year. Notice should be given division storehouses, on a form provided for the purpose, as to whether each of the different items of material would be furnished them from general storehouse or by purchasing department.

Filing and referring to Div. Storeh'se Requisitions.

A convenient way to file division requisitions at general storehouse is to use "Sisson's Magic Binder" or file book, using one for each storehouse. Then with the original notations made on requisitions as filed, it is an easy matter to locate any item of material that division storehouse may have occasion to wire or write about, and ascertain how it is to be furnished; that is, whether from general storehouse or being made in shops on lot or shop order number, or ordered on purchasing department to be sent direct, and if the latter, requisition number on which ordered will be shown and further reference to it can be had by use of impression book in which all requisitions made on purchasing department are copied in numerical order.

Stock-keepers Order Book.

For use of stockkeepers who have to order material, I would recommend book of following form:

CLASS NO. ....

Item.	Average Consumption past 60 days.	Quantity on hand.	Quantity required.	No. of Req'n on which ordered.	For what purpose needed.

Book to be handed in office and monthly requisition made up from it. Number of requisition on which items are ordered to be filled in by clerk making requisition, and if at any time stockkeeper finds himself running low on certain material, he knows the class it belongs to, can readily locate and is able to give requisition number on which item has been ordered, and thereby saves time of clerk looking up number of requisition on which ordered that may be taken up with purchasing department.

"The average consumption past sixty days" and "quantity on hand" is obtained from stock cards, use of which I will explain more fully later.

Numbering Requisitions.

I recommend that every sheet forming monthly order or requisition on purchasing department be given a number and known as requisition of that number, beginning a new series of numbers each year. Items appearing on certain requisition number are easily located by this manner of numbering.

Record Book of Material Ordered.

In order to avoid duplication of orders, to know whether material on requisition has been received and whether material for which invoice has been received was ordered as shown by invoice, the following form of book will be found very useful :

Record Material Ordered.

Date.	Quantity.	Items.	Req'n Number.

(Opposite page.)

Date.	Received.	Price.	From whom purchased.

The book is arranged in alphabetical order, and as soon as requisitions are forwarded, the material is copied in it from the impression book.

No invoice for material is passed for payment unless requisition number is given on face of it and appears on this order book.

After invoice has been checked with "Material Received Record," it is then checked and entered on this "Material Order Book" as being received.

I consider this a very valuable book indeed. The material being entered in alphabetical order is easy to locate ; you can tell at a glance whether any material of a certain class is due you, and if so, requisition number which is necessary; it shows by whom furnished, and price paid, which information is frequently required regarding some article a year or two back.

The question often arises how much material of any one kind has been received in a given time. By the use of this record the information can be given in a few moments.

RECEIPTS OF MATERIAL.

I would recommend that, as material is unloaded from cars, it be checked up by the receiving clerk taking blind tally ; that is, without any knowledge of what

has been ordered or what invoice bill calls for, entering it on an ordinary blank book, showing date, number and initial of car received in, from whom received, quantity and kind of material received, with notation as to whether any freight or advance charges, as shown by way bill he should have. Receiving Record.

This book is then handled by the invoice clerk the following day, and checked by triplicate invoice bills that the Purchasing agent should arrange be sent storehouse by shippers. Notation is made opposite each item on receiving book, in red ink of the requisition number on which ordered—this information shown on face of bill—and the number of bill (will explain later regarding numbering of bill).

This plan insures a good, honest and accurate check on the material received avoiding the possibility of accepting invoice figures when an error has been made in shipment, and the noting of requisition number and bill number opposite each item precludes the possibility of passing another bill for same material.

As a convenient way of handling in accounts and referring to invoice bills from purchasing department, I would recommend a storehouse number for each bill, beginning new series every year.

Triplicate bills sent to storehouse at time of shipment are checked on receipt of goods, and if O. K. nothing remains to be done when the original is sent by purchasing agent for "receipt" that he may use as authority for voucher, etc., but to stamp the bill and fill in the date, material received, number of bill and month in which taken into account in following form: Numbering Invoice Bills.

Material received .... checked and taken
into account in the month of ....
....19....
By.....................Storehouse Bill No. ....
....
Storekeeper.

This same information is stamped and noted on triplicate bill that is kept on storehouse file in numerical order.

Before returning bill to purchasing agent, the matter of freight charges is looked after, and in the event of any, the freight bill is attached to invoice sent purchasing agent that he may be governed accordingly in making settlement. Freight Charges.

The following information is stamped and noted on copy of freight bill returned local freight agent:

Accepted....... ....19....
and noted on Invoice filed at ....Shops
as No. ....

It will be noticed that the number of invoice bill is given in this receipt, and the numbers thus given are used by Freight auditor in rendering statement against purchasing department, and he in turn uses them in billing against storehouse.

On the triplicate invoice that is kept on storehouse file the following is stamped and information noted:

Freight Bill passed....... ... .1900
for $.....................and included in Purchasing
Department charges for.........................19....

This enables us to know whether there are freight charges on certain material, and how much, which is especially essential in the making up of price.

Monthly Statement of Charges from Purchasing Department.

At end of month the Purchasing agent sends the storehouse a statement of charges, in duplicate, showing number of bill, name of firm and amount, and if it checks up O. K. copy is receipted and returned, and total charges taken into account for the month.

Triplicate Invoice Bills.

There are several good features in having the triplicate bills as made by shippers. It is a saver of labor, and gives you notice in advance of material being on the way, which about that time is good information to have, as it is usually the few days preceding its receipt that it is badly needed and feel called on to "hurry it."

DISBURSEMENT OF MATERIAL.

Material once taken into storehouse stock should be carefully guarded, and all concerned should look upon it as so many dollars and cents, and be as cautious in giving it out as though it were their private mercantile stock—none to be issued except on the order of parties duly authorized to sign same.

I heartily recommend storehouse delivering all material to the shops for their use. It is a work for which boys at 10 cents per hour can be used mostly, requiring men for only the heavy material.

Storehouse Force Delivering Material to Shops.

The having of all departments of shops and storehouse under telephone connection will be found a great convenience and economical, especially with shops of any size. With this arrangement a boy can be located at the 'phone in storehouse to take orders from shops for material and perform such other duties as may be assigned him, and the required number of boys to report to him, get the orders, have them filled and delivered to party ordering.

I think by this method the cost of handling material from storehouse to shops can be reduced to a minimum, as it is a 10-cent boy against a 25 or 30-cent mechanic, and the boys will make two or three trips to the mechanic's one, as this is their specially assigned work. While with the mechanic it is, in a great many cases, their "ten or fifteen minutes off" to discuss politics and issues of the day.

Foremen's orders on Storehouse for Material.

The question of all requisitions made by foremen on storehouse for material used in shops reaching recording clerk and being properly accounted for, is one that gave me a great deal of concern.

If a requisition for a file, a few sheets of emery, or similar articles is lost, it would not amount to much, but if one calling for set of tire, flues, a pair of cylinders or other expensive material were lost, it would make quite a difference in book value and material actually on hand, to say nothing of inaccuracy of account chargeable with items called for by ticket lost. To overcome this I would suggest the use of numbered requisitions or tickets, in duplicate, of the following form :

No........ ....

Storekeeper :

Deliver to...

	ORIGINAL			

Charge........................

................................*Foreman.*

Each book containing 200 tickets—100 numbers—and as they are received from stationer's office the number of each book is recorded, and as given out the name of party issued to is noted opposite book number, and if in checking up tickets any number is found missing it will be known who to call on for duplicate. By the use of carbon sheets it requires no more time to write original and duplicate than it does to write the one order.

When material is sent out on the line and to division storehouses from general storehouse, an invoice should be mailed showing how and when shipped, requisition number or authority for shipment, article, quantity, price and amount. Invoice for Material Shipped from Storehouse.

The following is submitted as a convenient form :

INVOICE OF MATERIAL.

No. 1900

Shipped to.................. *at*..

In car No. ....

Req. No.	Description of Article.	Quantity.	Price.	Amount.	Material Account.

with detachable receipt at bottom, to be signed and returned to shipper for file.

For ready reference as to quantity of any item of material on hand at any time, monthly receipts and disbursements of same, I submit the following form of stock card as being first-class : Stock Cards.

. ...*RAILROAD COMPANY.*

Memorandum of ....*received, issued*

and on hand at...*Storeroom*

in units of...

January.		February.		March.		April.		May.		June.	
Rec.	Iss'd.	Rec.	Iss'd.	Rec.	Iss'd.	Rec.	Iss'd.	Rec.	Iss'd.	Rec.	Iss'd.

Note.—Amount remaining on hand at close of month to be entered at top of column for succeeding month.

Card starts with amount on hand first of month, the quantity received from time to time during the month is entered immediately under it, and as the material is issued to shops or shipped, it is entered in column "issued," and amount remaining on hand is carried to next column.

The use of this card will show at a glance the amount on hand at *any time.* It shows amount of your monthly receipts, amount used each month, and as the future can best be judged by the past, it is very valuable in determining future requirements (See mention made above, regarding use of stock card in making monthly requisition for material.)

If the card shows the same amount on hand from month to month, it is silent evidence that it is hard stock ; no more wanted, and steps should be taken to get rid of what you have.

Daily Report of Material Out.

It is from these cards that the average monthly consumption and amount on hand is obtained by stockkeepers in making up their monthly requisition for material.

While storekeepers strive to keep their stock in such shape as to be able to fill all orders presented them for material, they frequently find themselves out of some items, and in order to follow the matter up systematically I would recommend a morning report to the storekeeper of any or all items called for the day before, that they could not fill. The following is very good for the purpose :

....1900

Storekeeper :—

Following is list of material that we are out of, and for which have had call this date :

Items.	Quantity.	Number of Requisition on which ordered.

....Foreman.

The material shown on report may have all "been hurried," but the idea is to keep the fact continually before you, that you are out of certain material.

It will be noticed that the requisition number on which material was ordered is shown on blank. This is obtained from stockkeeper's book who furnishes information regarding shortage of material.

The requisition number, however, is verified in office before using it, in taking up with Purchasing agent.

Accounting with Auditor

As for the accounting with auditor, I will pass it over as not being expected or desirable here. I would simply say that I am wedded to the idea of dividing material up into different classifications or stock accounts, suggesting the following :

Coal,	Track spikes,	Paints and varnishes,
Oil and tallow,	Steel springs,	Iron castings,
Waste,	Rubber goods,	Brass castings,
Iron and steel,	Wheels and tires,	Axles,
Lumber,	Copper,	Manufactured material,
Pig iron,	Flues,	General merchandise,
Steel rails,	Tin,	Air brakes,
Angle bars,	Nails,	Stationery.
Track bolts,		

All material received and disbursed is to the debit and credit of whatever stock account it belongs to, and to handle in this manner, a "material ledger" of following form will be found convenient :

MATERIAL LEDGER.......................SHOPS.......................1900.

Items	Coal	Oil and Tallow	Waste	Iron and Steel	Lumber	Pig Iron	Steel Rails	Angle Bars	Track Bolts	Track Spikes	Steel Spring

Rubber Goods	Wheels and Tires	Copper	Flues	Tin	Nails	Paints and Varnishes	Iron Castings	Brass Castings	Axles	M'f'g Mat'l	Gen'l M'd'se	Air Brakes	Stationery	Total.

The chief end of this method is to give you ready information as to quantity in dollars and cents of different classes material used, and amount on hand. To use it is to appreciate it in many different ways.

Monthly Comparative Statement of Material Received and Disbursed

I have laid a great deal of stress in this article upon importance of keeping stock to a minimum at all times, and as it is not very good policy to suggest or recommend without also advancing an idea as to how it can be carried out, I would offer the following as being one of the best plans I have seen :

The general storekeeper should prepare and send to each division storehouse a monthly comparative statement showing amount of material on hand at each storehouse first of month, material received during the month, total amount disbursed, and percentage disbursement to total on hand and received. To make it more comprehensive, I give you below copy of statement as made up and sent out :

COMPARATIVE STATEMENT OF MATERIAL ON HAND AND DISBURSED.

January, 1900.

Shop.	On hand first month.	Received during month	Total.	Disb.	Per cent Disb. to total on hand.
A	$ 7,500.00	$ 5,000.00	$12,500.00	$ 4,375.00	35%
B	10,000 00	6,500.00	16,500.00	9,075.00	55%
C	9,000.00	7,000.00	16,000.00	6,400.00	40%
D	4,000.00	1,500.00	5,500.00	1,375.00	25%
E	3,000.00	1,500.00	4,500.00	2,700.00	60%
F	2,500.00	1,200.00	3,700.00	550.00	15%
G	1,500.00	900.00	2.400.00	1,200.00	50%
Total.......	$37,500.00	$23,600.00	$61,100.00	$25,675.00	42%

E Storehouse, first best showing.
B " second best showing.
G " third best showing.
C " fourth best showing.
A " fifth best showing.
D " next to poorest.
F " poorest.

NOTE.—Shop disbursing largest percentage of material considered best. One the smallest percentage the poorest.

This statement shows at a glance whether too much stock is being carried at any of the storehouses, and it also shows which of the storehouses are making the best and poorest showing in this respect.

I desire to answer in advance any question that might be raised as to whether or not a statement of this kind would not have a tendency to show increased disbursements in order to raise percentage of disbursements by saying emphatically, "No." The matter of expenses is always being guarded, and every possible action taken to keep to lowest limit. All kinds of statements are made.

With this close check on expenses, the next thing to do is to keep tab on material stock and see that excessive amounts are not carried. See how often it is being turned over. We all know that a merchant turning his stock or capital over

the greatest number of times during the year is the one who is getting the greatest good out of it.

Just so it is with a railroad storehouse. The one that turns his stock over the greatest number of times is the one that is getting the most service for the company out of its money. This fact conceded, how can we tell which one of the storehouses on the system is doing this ? The use of the above form gives it to you.

If the storehouse disburses but 20 per cent of its stock every thirty days, it is evidence it is carrying equal to five months' supply. If 60 per cent is disbursed it is carrying fifty days' stock.

At the bottom of the blank, different storehouses are recorded according to showing made ; that is, best comes first and poorest last.

Copy of the statement should be mailed each storehouse, with letter as merited—complimenting ones on good showing, taking others to task and asking for explanation as to why it could not do better, etc.

If there are but one or two storehouses on the line it is a good idea to have a record kept, showing what per cent of material is being disbursed monthly, for, when reduced to this fine point, you can tell at a glance whether excessive or not.

To insure accuracy of charges, it is essential that the price book be well kept. Price Book
With a great many, prices are entered in pencil, and as changes occur amounts are erased and others entered. This I do not consider good practice, and would recommend a book of the following form :

..............................Railroad Company ....Shops.

PRICE LIST OF MATERIAL AT STOREROOM.

Prices should be recorded only as established or changed ; and

Items.	How classified in accounts.	Units on which prices are based.	Price.	Price.

(Opposite page.)
Dates of changes should be shown on line immediately under word price.

Price.	Price.	Price.	Price.	Price.	Price.	Price.

(and eleven other columns marked "price" consuming full width of the book.)

The items are all entered in alphabetical order. It is quite a little job to do this but so it is with any price book, as all items have to be entered. When once written up, however, a book of this form will last three or four years

As will be seen, provision is made for as many as nineteen different changes in the price, and price is only to be entered as it changes from time to time. I would here offer a suggestion that if the storekeepers, through a committee of five or six, would agree on and formulate a price book with all items usually carried in a railroad storehouse, that some enterprising stationer or bookmaker could be induced to print and place on market at reasonable price a "standard railroad storehouse

price book," thereby saving a great deal of labor involved in writing up items, etc., of the book.

Shipment of Scrap or other Material to Individuals.

The shipment of scrap or any other material to firms or individuals is of especial importance, as, with the shipment, material passes out of hands of company and such check should be had as to absolutely insure invoice being rendered for it.

To secure this I suggest the following plan. Record of each sale made kept in a blank book as follows:

Local sale No. ....
Authority for sale ....
Purchaser..
Kind of material..
Quantity....................
Price................

SHIPMENTS MADE.

Date.	Car No.	Initial.	Gross wt.	Tare.	Net wt.	Amount.	Bill No.

As soon as notice is received of sale being made (all of which should be done by purchasing agent same as buying) it should be recorded in accordance with above.

When material is loaded, and before any way bill or shipping ticket has been made, it should be recorded under head "shipment made." This done there is no chance for car being shipped and no invoice to cover.

Catalogue Index.

As matter of convenience every storehouse should have a book rack or case for filing catalogues, and should have them all entered in an index book in alphabetical order, giving a number to each book and dividing the rack or case up into compartments so as to accommodate from ten to twenty-five books, alloting certain series of numbers to each compartment and keep books in respective compartments in numerical order.

Your index should show name of firm, kind of material handled and number of catalogue. With this arrangement you can lay your hand on any catalogue you have in a minute's time.

Special Color for Rush Orders.

Another item, while it is small (it is the little conveniences that assist one in dispatching work), I think it is a good idea to have all "rush orders" made on special color of paper, say, pink or any other preferred. By this, you can always tell at a glance that you have a "rush order" on hand that should be given preference.

While it is understood that special request to hurry can be made on face of an

order, still you have not that silent evidence staring you in the face as long as on hand, that you have with a specially colored one.

Concentrating Supplies in one Building.

I favor the plan of concentrating material in one building as much as possible. The only material I would separate is iron, boiler and tank steel. For this, I think there should be a building located near the blacksmith and boiler shops with track through it, and if receipts of iron warranted it, a track scale in house to weigh the iron on.

The storehouse should have good light. Dark corners result in storing material out of sight, an expensive practice. All material that can be so accommodated should be carried in shelving divided off into compartments of suitable size.

Storehouse Divided in Sections.

I recommend that every pocket, bin or shelf in which material is stored be given a number, and that the storehouse be divided off into sections—one hundred numbers to the section—and that tabulated lists of material in each section, showing number of bin and the name of material, be framed and placed at beginning or end of section.

Storehouse Index.

A very valuable book, indeed, especially so in case of large stock, is an alphabetically arranged list of all material carried, showing section and number of bin in which located. It might properly be termed "storehouse index." For instance, a 1½-inch angle valve is wanted. By turning to "V's" we find it in section "H," bin No. 39. This is very useful for one not familiar with the entire stock, such as the night man, or in case of temporary absence of any of stockkeepers, or change in men, etc.

Discounts Shown on Invoice Bill.

Having devoted all of above to plans for "helping ourselves," as seen from my standpoint, I desire in conclusion to endeavor to interest our friends, "the hardware and supply men," in our behalf through the purchasing agents, by having them invoice material furnished at net prices, instead of with the long string of discounts as given on a large amount of the supplies used by railroad companies.

I appreciate convenience to hardware men of having "list" price on article and change net price by changing discount, but with storehouses it is quite different. We must have a net price on every article received into stock for price book, aud for charging out to accounts. For instance, every dozen wood screws or twenty-five cotters issued has to be charged to account drawn for and net price used; hence, when invoice bill is received with twelve or fifteen items, each bearing from two to four discounts, it means obtain net price on every item, and when from nine hundred to fifteen hundred bills are handled per month, the figuring of discount on every individual item means a great deal of work for the storehouse, and any move tending to remedy it will, I am sure, be appreciated by all storekeepers.

President Hetzler: This is certainly a very instructive and interesting paper, and should be thoroughly discussed. I will ask Mr. Hubbell to start the discussion, this being in his line.

Mr. Hubbell: A railway company's material stock is necessa-

rily somewhat different from a stock of merchandise carried by a manufacturer or jobber.

The railway material account is what you might express in few words as "an expense." Therefore, there should not be added to this expense anything that can be avoided, and in the receiving, caring for, and issuing, there should be only just that expense put upon the first cost of material which is absolutely necessary in order to show, in the first place, that the railway company has received what it purchased, that the material is not misappropriated nor wasted.

I do not believe that any person, or persons, can lay down arbitrary rules under which this fact can be accomplished; but on the other hand I think, generally speaking, each local situation must be treated in accordance with its peculiar conditions, and I believe that the best results will be accomplished on those lines where first a careful analysis is had of the conditions as they exist, and then the system for accomplishing the end is shaped in accordance with the requirements.

In view of the large proportion of the total of the expense of operating a railroad covered by material and supplies, I believe that those who have the active management of these matters should be chosen for their work because of their peculiar adaptation to the requirements of the situation.

Some years ago I was placed in charge of one of the largest material accounts, probably, to be found upon any western road. This stock consisted of hats and caps, boots and shoes, all kinds of clothing, nearly $300,000 worth of groceries, and every other item of material and supplies that enter into the construction and maintenance of a railroad.

I have always thought that an exceedingly practical system of handling the work was inaugurated. Probably this is largely because I did it, and you know what each of us think of the "I" when each in turn is the "I." I think the best thing connected with the organization of that business was a book, which was called a "Stock Ledger," which was a book appropriately ruled, and which easily permitted the keeping of a debit and credit account of each and every item in the storehouse.

The railway referred to was a system of some 2,200 miles, and the amount of stock that we had on hand at the time referred to, necessi-

tated one clerk to keep this record, and keep it in proper shape, and who received, I believe, $65.00 per month ($780.00 per year). The book for the year's work cost, probably, an additional $20.00, making total expense for running this stock ledger $800.00.

The stock, at the time this system was introduced, represented a ledger balance of two and three-fourths millions of dollars. In a little over two years' time we cut this balance down to less than $500,000.00, or a saving of two and one-fourth millions of dollars.

The bonds were 7 per cent bonds. It is a simple mathematical calculation that an investment of $800.00 annually, saved an excess of $156,000.00 annually in interest.

I subsequently had occasion to slightly modify the form of stock ledger referred to, and submit with this a sheet from the modified book, in which the stock ledger was made also to serve as an accurate price book for storehouse department, and showing all changes in prices as they occurred.

RECEIVED			PRICE		ISSUED		RECEIVED			PRICE		ISSUED		RECEIVED			PRICE		ISSUED	
Date	From	Quantity			Date	Quantity	Date	From	Quantity			Date	Quantity	Date	From	Quantity			Date	Quantity

I concur in the suggestion made by Mr. Taylor, that in a properly organized storehouse department, all requisitions from subordinates properly approved for filling by the heads of their respective departments, should be forwarded to the general storekeeper. The general storekeeper can very readily turn to his stock ledger, to which I have referred, and if quantities called for are excessive, he can quickly communicate with the proper official, and after this question of quantity is intelligently adjusted it is a simple matter for him to determine how much material he has on hand for filling the requisitions, and in an intelligent manner he can make requisition for such supplies as are needed to maintain a legitimate, necessary stock.

I do not believe, in this connection that it is desirable, advisable or justifiable to undertake to maintain a dollars and cents account with various classes of material in stock, in that in the first place it is a physical impossibility to do so accurately, and one guess is just as good another. I justify myself in this statement from what obtains in mercantile life. No merchant expends the money that would have to be expended to keep up such an account.

Requisitions from the store department when they reach the purchasing agent should have the purchasing agent's consideration with regard to quantities called for, and no one should feel hurt if the purchasing agent asks if the quantity asked for is not excessive.

Quarterly the general storekeeper should give to the purchasing agent a summary of the issues of all purchases and supplies, as determined from the stock ledger. Two heads are better than one. The store department should be under the direct supervision of the purchasing agent and the employes of the purchasing office and in the store department should recognize the fact that they are not an organization exclusive and independent in themselves, but that they belong to the entire road, and their business is to aid and abet the head of any other department in the one grand effort of producing the best possible results at the least .possible first cost

I think it is a useless expense, in either the storekeeper's office or in the purchasing agent's office, to make hard copies of requisitions received or made for purchase. Care in making impression copies of the requisitions made for purchase will give as complete a record of the requisition as is necessary, and if it is desired to keep a special record of what has been ordered, a red ink interlination on the "received side" of the stock ledger readily accomplishes this purpose. Requisitions received to be filled can be properly checked to cover issues.

The purchasing agent should always send to the store department, as well as to all other parties, carbon copies of his orders for purchases made on their requisitions, and those who receive this information should at once turn to the impression copy of their requisitions and note on the impression copy reference to this order number, and if asking the purchasing agent to hurry the material, reference to this information will prove generally beneficial.

What I have already said will apply to Mr. Taylor's recommendations with regard to the storehouse account to the auditor. It is neither necessary or desirable that a large portion of the detail of the storehouse account shall be spread upon the auditor's books, nor be on file in the auditor's office.

The storehouse statement to the auditor should begin with his balance of material on hand, with an abstract giving information as to the bills of purchase taken into account, as well as the charges from other departments taken into storehouse account, with an abstract

giving similar information with regard to disbursements of materials. This, with the stock record properly kept, supplemented by the annual inventory of materials on hand, gives the accounting office every possible check on storehouse matters that may be desired, or that is necessary in accurate accounting.

The judicious use of the stock record referred to will accomplish a great deal more good, in a practical way, than a comparative statement in dollars and cents of the materials issued and received, as comprehended on page 11 of Mr. Taylor's paper. This record, however, as recommended by Mr. Taylor, takes very little time, and there is no objection whatever to its use, if desired ; but the best time to lock the barn is before the horse is gone, and the best time to curtail surplus stock is before the surplus stock is accumulated, and this you can do, because I have done it by use of the book mentioned. I have not only done it once, but twice, and it can be done any number of times if given the opportunity.

I think Mr. Taylor has very ably handled the subject before the Club, and, personally, I thank him for the masterly manner in which he has presented the subject, and I know that the members of the Western Railway Club can improve in their economies of operation by thoughtful consideration of what has been said in this meeting.

Mr. J. M. Taylor (Illinois Central R. R.): Regarding the stock ledger Mr. Hubbell speaks of, the same results are obtained from the use of the stock cards I suggested, namely, monthly receipts, disbursements and amount on hand of all the individual items. They even go further, and show at a casual glance the average consumption for any thirty or sixty day period, and, furthermore, the cost of handling with the cards is reduced to a minimum as compared with the ledger plan.

As for the material received being checked from press copies of original requisitions, I cannot say that I altogether agree with Mr. Hubbell. I think we should have better ready reference, as we all know from experience there is hardly an hour in the day that we do not have occasion to refer to an order made for some item of material. By having all the items copied in alphabetical order in a material order book from the requisitions, as I suggest, you can turn to any item promptly. For instance, you are running low on firebox steel or flues, and desire to "hurry them ;" you have but to look under "S" or "F" of index for the page it appears on, and by referring to it you

find that they were ordered on a certain requisition and date, whereas, with Mr. Hubbell's plan, you may have to look over from three hundred to five hundred press sheets, as the items may have been ordered three or four months back.

I thoroughly agree with Mr. Hubbell that it is a good idea to have the storekeeper advised with whom orders for material have been placed, and with the permission of the purchasing department he can take up with the different firms the matter of delivery, thereby assisting the purchasing agent and at times avoiding delay to important work. This, however, is not viewed in the same light by all purchasing agents.

With reference to the making of hard copies of requisitions, and Mr. Hubbell's objection to the plan, I am not altogether prepared to say whether that is the best plan or not. There are arguments for and against it. If you do not make the copies as I suggest, you have to place requisitions as received in the hands of stockkeepers. This takes them out of the office where, I consider, they should be filed for reference.

The placing of these orders in the hands of the stockkeepers necessitates higher priced men, and this increased price and labor required to write up "back orders" will, I think, exceed or fully equal the $10.00 or $12.00 that it will cost per month to make the hard copies.

Mr. J. P. Murphy (C. & N.-W. R. R.): Referring to the carrying of excessive stock by storekeepers, a point made by Mr. Taylor in his paper. The storekeeper being entirely dependent on others for advice as to the quantity, etc., of stock, I would suggest a committee for the purpose of defining a form report or blank, having printed thereon the technical names of the more important articles. For instance, of a locomotive ; supposing an engine was taken into the shop for general overhauling, and if a list enumerating the more important articles which this particular piece of work would require, could be handed at once to the store department, the storekeeper would be in a position to prepare himself with material, and avoid delay to the engine, and also avoid carrying in stock an excessive quantity of this class of articles.

The assistance of the motive power department should be solicited along these lines. The list of articles would probably cover tire, driving boxes, brasses, cylinder bushings, etc.

Mr. Hubbell: One suggestion that has just been made is to be

anticipated by the regular requisitions for its supplies which the head of the mechanical department makes. For instance, they know today that about sixty days from now, engine No. 99 is going to need a new set of tires, and there is no tire maker that keeps those tires in stock, hanging by a thread, just simply cut the thread and drop them down when we want them and where we want them ; you have got to make requisition in advance, and there is some little delay following the shipment even after the purchasing order has been made, and I think all such matters as suggested by the remarks just made are covered by the regular requisitions that the mechanical department will make on the storehouse, and the storekeeper not having them in stock makes his requisition on the purchasing agent through whatever channel pertains to the particular lines.

Mr. G. F. Slaughter (C. & N.-W. R. R.) : Mr. Chairman, I am sorry we departed from our subject as to the "relative merits of impression copies." I do not think Mr. Taylor objected to them. I agree with Mr. Hubbell that the initial movement should tend to the final ; that we should have as little copying and little duplication as possible. We use a triplicate form of requisition which when written once is the only writing necessary. We retain the impression copy in the office ; one of the other copies goes to the receiving office and one to the invoice clerk ; that is the last there is of it—there is no more writing. We did employ a man who did nothing else but that work, but his services were dispensed with.

There is a question on which I want to get some information, and that is about triplicate bills being made by the shipper. I wanted to ask Mr. Taylor if the triplicate bill was sent from the shipper to the party who was to recive the material, or to the general store?

Mr. Taylor : Usually they are sent to the parties receiving the material ; with some they are sent direct to the general store.

Mr. Slaughter : Do you meet with any difficulty in having that system in vogue ?

Mr. Taylor : None whatever.

Mr. Slaughter : I asked that question for the reason that I have been told it is very difficult to get the shippers to do this ; they object to the extra expense for postage.

This last paragraph, which you did not read, in regard to the question of discounts and net prices, is largely a question for supply men, and I suppose there are a number of them here. I would like

to hear the question discussed as to whether it is not practicable to have prices quoted net instead of discount. Of course, the system now in vogue entails an immense amount of work. Probably there is some one here who can discuss this from the supply man's standpoint.

Mr. Hubbell: I want to speak just a moment about the matter of triplicate bills. Invoices are rendered in my office in triplicate. It is an imperative rule that all invoices received in the offices in the morning must be mailed to the proper heads of the departments that night. The triplicate invoice is filed in the purchasing agent's office, the original and duplicate invoice with the bill of lading, express receipt or receipt of person to whom the goods are delivered, are sent forward to the party making the requisition. The original bill is attached to the voucher and the duplicate bill is filed in the office of the party taking same into account. On these original and duplicate invoices that go out we have a little stamp, which gives reference to the department's requisition number and the point at which the goods are purchased, delivered f. o. b. cars, the point from which the goods are shipped, giving the party then who receives the material all the information about conditions of purchase and shipment which in conjunction with the carbon copy that has already been sent to the person making the requisition they know just as much about the transaction as the purchasing agent, and they are fully advised regarding it.

Mr. Slaughter: I would like to ask another question of Mr. Hubbell. Speaking of deliveries of material, do the invoices which go to the party interested, show the point from which the material is shipped?

Mr. Hubbell: That is covered by the stamp put on in my office.

Mr. Slaughter: Then the invoice itself does not show that?

Mr. Hubbell: Yes; it is noted on the invoice, the invoice shows to whom shipped and it is also covered by the rubber stamp put on the invoices in the purchasing agent's office.

Mr. Tucker (C. & N.-W. R. R.): Mr. Slaughter expressed my views pretty thoroughly in regard to requisitions, etc., and I am in full accord with him in regard to carbon copies for the extra records for requisition, and transcribing so often is not necessary. I did not come prepared to say anything on the paper.

Mr. Murphy: Before passing this matter of discount I would like to hear from somebody present in regard to getting the net price of materials. It seems to me if we could get the net price on mate-

rial instead of list price with discounts, it would be of great assistance in handling material.

Mr. S. W. Rossiter: If a purchasing agent asks for the net price, he gets it, always.

Mr. Hubbell: I do not want to monopolize this meeting. I simply want to tell the last speaker that that is not so, and I want to tell a little story about this discount business.

A great many of you know that I was Mr. Fairbanks' "hired man" for twelve years, selling various things that he had to sell. I used to rail about this discount business, quite as much as a salesman, I think, as I have as a buyer, and a person told a story about a party that started in one day making jackknives, and he was not going to sell jackknives the good old-fashioned way. The idea of selling jackknives at 80-20-10 and 5 off! He was going to do away with this and sell jackknives at so much net. Well, he went out and tried to sell them that way, but there could not anybody tell whether his price was higher or lower than anybody else's, and he had to go back to selling jackknives the same as the balance of them did—sell them on discounts. It is a matter of great convenience to manufacturer and buyer to use the list prices and discounts, and necessitates the remembrance of less figures, and I like the discount better than I do the net price, because, for reason just stated, if you have a long line of articles figured out on a net price all the way through, you have a large number of prices to keep in your noddle, but with a discount that applies on all of them, it is an easy matter to carry. Take, for instance, the single item of pulleys; all railroads use more or less pulleys, and when they are sold upon discount, one man quotes discount, and another man quotes discount, it is a way of quick comparison. A great many manufacturers publish complete discount tables and they will supply any railroad official with those tables who will ask for them, and from these discount tables you can quickly get your net price on any item.

Mr. Rossiter: That lets the purchasing agent out, but that is not what Mr. Slaughter asks. He wishes to do away with the figuring. We figure it to the net, the purchasing department figures it to the net and the storekeeper figures it to the net. Why not have it net in the first place?

President Hetzler: If there is no further discussion, I will ask Mr. Taylor to close the argument.

Mr. Taylor: I do not know that I have anything further to say. A great deal of stress has been laid on the item of extra labor involved in making hard copies of requisitions received, in order to retain originals on office files. I am sure that extra amount paid a high priced stockkeeper to look after the material and act as custodian of requisitions will more than equal the cost of making the copies, to say nothing of convenience in having originals filed in storekeeper's office.

Referring to remarks about list prices and discounts allowed on same, I have, since preparing article just presented, received a bill with goods charged at list price, with discount of 60-10 and 5 off, and not being satisfied with this, they then added 20 per cent on.

Such as this means extra work that I think steps should be taken to avoid.

Before closing, I wish to draw attention to matter of price book.

In conversation with Mr. Tubby, general storekeeper of the Great Northern Railway, a few days ago, he informed me they had a printed price book—cost them something like $400.00 for four hundred books.

I think that a committee of four or five storekeepers could prepare a price book in such form as to be suitable for all railroads, and this done, could get some one to take hold of, have printed and placed on market at such a reasonable price that no one could afford to spend time required in writing up a book as is done now by most roads. I would like to see some action taken along this line.

Mr. Carse: The chief clerk of the purchasing agent of the C. & O., Richmond, Va., has published a book of that kind.

Mr. Slaughter: One of the defects of the printed price book, or price list, is this: you probably have 3,500 names of material in this book, but only have prices to extend on 1,500. It is then necessary to turn over, in posting, a large number of useless pages. Again, the list itself on a large railroad is up-to-date today and tomorrow full of obselete material.

We have a price book that is simply headed at the top "Name of Article," and the months run along for two years.

Mr. Taylor: That was my idea in suggesting committee of storekeepers. They would know what items to include and not burden book with three or four thousand unnecessary articles.

Adjourned.

Rules as Recommended Changed.

The following are the sections in which changes were recommended by the committee and members, the changes being approved by the Club. The additions are in italics :

Rule 3, Section 1, second paragraph: Defect cards shall not be required for defects for which owners are responsible, except for missing material on cars offered in interchange as provided for in sections *20 and* 32 of rule 3, etc.

Rule 3, Section 17 :

Sec. 17. Axles less than the following prescribed limits :

CAPACITY OF CAR.	JOURNAL.	WHEEL SEAT.	CENTER.
100,000	5 inches.	*6⅝* inches.	5⅞ inches.
80,000	4½ "	*6¼* "	5 5/16 "
70,000	4 "	*5½* "	4⅞ "
60,000	3¾ "	5 "	4⅜ "
50,000	3½ "	4¾ "	4⅛ "
40,000	3¼ "	4⅝ "	3⅞ "
30,000	3 "	4¼ "	3½ "
20,000	2¾ "	4¼ "	3½ "

All cars to have their capacity stenciled on them.

Rule 5, Section 10. The weight charged for new journal bearings for 7 inch journals or over, but not 8 inches long, shall not exceed 10 pounds; the weight charged for new journal bearings for journals 8 inches long and less than 9 inches long, shall not exceed 13 pounds, and for new journal bearings, 9 inches long or over, but not 10 inches, 20 pounds. The weight charged for new journal bearings for 100,000 pound capacity cars (5½x10) shall be 25 pounds. The weight of scrap credited must be one-half of the weight of the bearing charged *whether repaired on defect card or not.*

Rule 5, Section 13 : M. C. B. couplers and parts of same of whatever make when new, shall be billed as follows :

One coupler, complete, *$8.00.*

One coupler body, *$5.00.*

Other individual parts, malleable *or wrought,* 3½c. per lb.

Other individual parts, steel, 4½c. per lb.

Credit for broken parts renewed shall be at rates given in sections 10 and 14 of Rule 5.

Rule 5, Section 19 : The Club recommends that the words "*renewed*" and "*replaced*" be used in this connection in accordance with their proper grammatical use.

At end of items of work enumerated add : *Truck transoms 2, wood, replaced, same truck, 12 hours, $2.40; 12 hours, $2.40.*

Rule 5, Section 21 : In the list of air brake charges add :

Angle cock repaired, 10c.

Check valve, ground in, 5c.

Rule 5, Section 22, last paragraph. When cars of 60,000 pounds capacity, *and under 80,000 pounds capacity*, and so stenciled, have trucks with journals, 4 inches or over in diameter when new, $25.00 per car shall be added to the figures as given above for the values of car bodies.

When cars of 80,000 pounds capacity or over, and so stenciled, have trucks with journals 5 inches or over in diameter when new, $40.00 per car shall be added to lhe figures as given above for the values of car bodies.

Rule 5, Section 26. Switching roads will only be allowed to render bills against car owners for the following defects made and repaired by them: roof lost on account of decay or faulty construction, *worn-out brasses*, broken truck springs, truck transoms, arch bars, *draft timber bolts*, column bolts, truck hangers, truck transom truss rods, truck bolsters, truck bolster truss rods, oil boxes, spring planks, truck hanger pins, side bearings and center plates, provided the damage has not been caused by derailment or rough usage. They will be allowed to render bills direct against car owners on all car owners' defects on cars received by them from a railroad company, provided they procure joint evidence from the delivering road that such car owners' defects existed when the car was delivered by the railroad company; joint evidence to accompany the bill against the owner.

A switching road is a corporation doing the major part of its business on a switching charge, or one which does not pay mileage for handling cars.

Rule 6, Section 3: If only the body of a car is destroyed, and the company destroying it elects to return the trucks, they shall be put in good order, or be accompanied by a defect card, covering all defects or improper repairs made by them for which owners are not responsible, and forwarded, within 60 days, free of freight or other charges, to the nearest point on the line of the company owning or operating the car, and the number, line and class of car destroyed shall be stenciled or painted on each truck so returned.

Railroad companies having their car repairs pooled shall accept repaired trucks at any point within the territory of the pool.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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THE regular monthly meeting of the Western Railway Club was called to order at 2 p. m., Tuesday, May 15, 1900, in the Auditorium Hotel, Chicago. President H. G. Hetzler in the chair.

The following are the names of those who registered:

Angell, F. R.
Bayley, R. W.
Bischoff, G. A.
Blanchard, W. A.
Bradeen, J. B.
Brazier, F. O.
Breckenridge, Prof. L. P.
Brown, I. H.
Clark, F. H.
Cockfield, Jos.
Conger, C. B.
Cooke, Allen
Cota, A. J.
Crosman, Walter D.
Cushing, Geo. W.
Dean, Nat.
Deems, J. F.
Delano, F. A.
DeRemer, W. L.
Eames, E. J.
Elliott, W. H.
Feldman, A. M.
Forsyth, A.
Gardner, J. W.
Gollmar, Geo. J.
Goss, Prof. W. F. M.
Haskell, B.
Hetzler, H. G.
Hill, Jas. W.
Hone, A. C.
Hubbell, Ira C.
Hyndman, F. T.
James, G. W.
James, T. H.
Jennings, D. F.
Kastlin, Jacob
Keegan, J. E.
Keeler, Sanford
Kerr, Prof. C. V.
Kirby, T. B.
Love, W. A.
Mackenzie, John
Manchester, A. E.
McAlpine, A. R.
McAndrew, M. J.
MacBain, D. R.
McNaughton, James
Mills, Geo. F.
Otis, Spencer
Otley, Benj. F.
Otley, Samuel
Parish, L. G.
Peck, Peter H.
Pennington, B. C.
Pierce, Chas. F.
Pratt, E. W.
Raidler, J.
Reilly, T. S.
Rennolds, W. C.
Reynolds, J. N.
Riley, J. G.
Robinson, J. G.
Rogers, M. J.
Royal, C. B., Jr.
Sargent, F. W.
Sharp, W. E.
Sinclair, A.
Smith, L. L.
Smith, R. D.
Spear, F. R.
Stewart, Sam'l C.
Sullivan, Chas. L.
Swan, C. A., Jr.
Taylor, J. W.
Thompson, W. O.
Tratman, E. E. Russell
Wheeler, Jno. T.
Wickhorst, M. H.
Willsie, A. N.
Wilson, H. M.
Zeleny, Frank

President Hetzler: The minutes of the last meeting will stand approved, as published, if there are no objections.

I will ask the Secretary to read the names of new members, as accepted by the Board of Directors.

The Secretary then read the following:

Edward McCarty, Round House Foreman, Ill. Central R. R., Chicago.
F. Schuchman, Homestead Mfg. Co., Homestead, Pa.
C. B. Ault, Homestead Mfg. Co., No. 9 So. Canal St., Chicago.
D. C. Buell, Purdue University, Lafayette, Ind.

President Hetzler: Gentlemen, this is our last meeting before the summer months. We will take up the paper by Prof. L. P. Breckenridge, "Locomotive Road Tests; How They Should be Made," and after this paper has been discussed, we will hear the reports of our Secretary, Treasurer and Library Committee, and after that, election of officers.

We will now take up Prof. Breckenridge's paper. I will ask him to make such remarks and review as he desires.

Locomotive Road Tests—How Should They Be Made?

By L. P. Breckenridge

Professor of Mechanical Engineering, University of Illinois, Urbana, Illinois.

It is perhaps wise to admit at the beginning that the writer chooses this subject from a somewhat selfish reason, namely, with the hope that the members of this Club will freely indicate their feeling and experience relating to this subject, to the end that the writer may gain the benefit of the ideas and suggestions offered, and that these may aid in more successfully carrying on certain road tests which are now being planned and executed.

The first work of the writer relating to tests of locomotives was done during the summer of 1887, for the Boston & Albany R. R., at Springfield, Mass. Since that time, either as assistant or in charge of the work, tests have been made on the Connecticut River R. R., Lehigh Valley R. R., Illinois Central R. R., and Big Four R. R.

Participation in work of this kind has directed my attention to the work of others, and everything available concerning the subject has been carefully read. Doubtless, however, much has escaped me.

There are some methods which I have not seen suggested that I shall propose, which I am sure will simplify matters, and which it seems to me will be more satisfactory than some of those usually adopted.

"A Standard Method of Conducting Locomotive Tests"* was recommended to the American Society of Mechanical Engineers, in 1893, by a committee of marked ability, consisting of ten persons, and no one should fail to familiarize himself with this report before undertaking locomotive testing.

In this report the recommendations cover both the "laboratory tests" and the "road tests."

You are all well aware of the exceptional facilities which obtain at Purdue for laboratory tests, and during the last ten years no one has given more thought and attention to this subject, or accomplished more than our fellow member and vice president, Professor Goss.

The difficulties which attend the carrying out of reliable road tests are so great that not a very large number of such tests have been attempted, and many that have been attempted cannot be said to have been very satisfactory.

I do not by any means wish to have you think that the writer has solved all of the difficulties, but some of the methods now in use in the "Dynamometer Car No. 609," owned by the University of Illinois and the P. & E. division of the C. C. C. & St. L. Ry., may be of interest in this direction.

The object of making "locomotive road tests" is to determine, if possible, the efficiency of the locomotive when engaged in its regular work. The intimate con-

* See Vol. 14—Trans. A. S. M. E.

nection of boiler and engine makes it evident that in tests of this character the combined efficiency of both should be considered.

A locomotive is designed to haul cars, which it accomplishes by exerting a pull at the drawbar. The power developed at the drawbar back of the tender during a given run corresponds to the brake horse power, or power delivered at the circumference of the belt pulley of a stationary engine. Coal is burned on the grate in order that this power may be developed at the drawbar.

If the results of a test were of interest only to the road on which they were made, the final efficiency might be given as the number of pounds of coal burned per hour per drawbar horse power. If, however, the tests can be made reliable, they become of widespread interest, and immediately the questions arise: What kind of coal was used? What was the evaporation of the boiler? What was the power developed in the cylinders? So that, in addition to the above results, there should be given also such other ratios as will make tests comparable.

The length of the run should never be much less than 100 miles. It is important to give as a part of the report a description of the character of the road bed over which the tests are made, bearing particularly in mind that the resistance of the locomotive itself on curves is twice as great per ton as the cars it hauls, so that any locomotive will be less efficient on a division having a large proportion of sharp curves than on a division consisting mostly of straight track, assuming that the drawbar horse power is taken as the unit for comparison.

For a complete road test the following determinations must be made during the test:

ITEMS FOR THE BOILER.

1. Weight of coal burned.
2. *Weight of water evaporated.
3. *Temperature of feed water.
4. *Steam pressure.
   (These four are essential and of first importance.)
5. Weights of ashes and smokebox cinders.
6. Moisture in coal.
7. Temperature of escaping gases.
8. *Vacuum in smokebox.
9. Quality of steam.
10. Height of water in boiler.

ITEMS FOR THE ENGINE.

1. Indicated horse power.
2. *Time of taking diagrams.
3. *Drawbar horse power.
4. *Revolutions per minute of the drivers.
5. *Speed in miles per hour.
6. *Time of all stops and starts.
7. *Steam chest pressure.
8. *Position of throttle valve.
9. *Position of reversing lever.
10. *Location of mile posts, stations, bridges, etc.
11. Oil used.

MISCELLANEOUS ITEMS.

1. Length of time calorimeter is running.
2. Length of time blower is in operation.
3. *Length of time safety valve blows off.
4. *Number of strokes of air pump.
5. *Number of times whistle blows.
6. Slip of locomotive drivers.
7. *Temperature of atmosphere.
8. *Wind, weather and rail conditions.

To these determinations must be added the following:

1. Analysis of coal used.
2. *Description of coal used.
3. Calorific capacity of coal.
4. *Train weights.
5. *Character of train.
6. Complete description of engine and boiler, including photographs and all dimensions and proportions in any way involved in the calculations.
7. *List of train crew.
8. *List of observers.
9. *Date and duration of test.

It is not to be wondered at that the determination of such a large number of items as are given above should be a matter of considerable difficulty, and when tests are undertaken by persons not familiar with the difficulties, their first attempts are usually unsatisfactory. Even to those with the requisite experience, there are no tests involving greater difficulties, or that require more careful preparation before, or more careful analysis afterward, than locomotive road tests.

It has been the object of the writer to endeavor to reduce the difficulties of making locomotive road tests, and at the same increase the accuracy of the results obtained.

In 1898 the University of Illinois equipped Dynamometer Car No. 609. This car was built by the Peoria & Eastern division of the C. C. C. & St. L. Ry., and it is operated for the mutual advantage of the two interests involved. Although originally designed to serve as a means of measuring and recording the drawbar pull, it was soon seen that many of the observations necessary for road tests could be more conveniently made from this car.

It willl be seen that with this arrangement considerable time and trouble involved in attaching various devices to the locomotive will be avoided, but what is of more importance, these devices can be mounted more substantially and can be read and looked after more easily, while in many cases the desired results may be made self-recording.

Another very important advantage which this method secures is that fewer observers are necessary on the locomotive itself. The use of the car also furnishes ample accommodations for the necessary supplies, instruments and tools, as well as for the clothes of the observers. It also adds much to the safety and comfort of the party.

*These observations are made or recorded in the dynamometer car.

In the above items required for a complete test, those that have thus far been successfully taken in the car, or for which apparatus has been designed and is being constructed, are indicated by a star, the others being still made from the locomotive, or in the case of several items made the subject of subsequent determination.

It will thus be seen that out of a total of thirty-eight items, twenty-five are arranged for in the car, seven are such as require no observations during a test, and six are still required to be taken from the engine. These six items are as follows:

1. Weight of coal burned.
2. Temperature of escaping gases.
3. Quality of steam.
4. Height of water in boiler.
5. Indicated horse power.
6. Length of time, blower is in operation.

For these observations three men on the front end and one in the cab are sufficient, and one of the men in front could be dispensed with, if necessary, as his only work would be to get the temperature of the escaping gases, and to render some assistance to the two men at the indicators.

PREPARATIONS FOR THE TEST.

The reasons for making any particular tests will determine largely the details of the preliminary arrangements, and while all the methods of procedure cannot be touched upon in this paper, there are nevertheless some suggestions to be made as the result of past experiences, which the writer hopes may be of value.

Weight of Coal.—This important item usually involves considerable preparation and careful watching in order to insure correctness. Estimated bin weights, or bulk weights in tender weighed on track scales while attached to engine, are not satisfactory, particularly when allowances must be made for variation in height of water in tank.

The preferable plan is to use coal previously weighed on scales known to be accurate. Eighty per cent of the coal necessary to make the run may be estimated and carried in bulk ; the remainder should be put in bags holding 100 pounds each. It is only necessary that all the bulk coal shall be consumed during the run, in order to know the total amount used without the necessity of weighing back unused coal, and frequently only a few bags will be used if the estimate can be made closer than the assumed 80 per cent.

Weight of Water.—In addition to placing a meter on the suction pipe of the injector, from which readings may be taken, it is desirable to calibrate the tank by placing it on accurate scales and weighing in, or out, in uniform amounts of about 500 pounds, the water it contains when standing level. One-half inch connections should be tapped into the tank at nearly opposite corners (a vertical plane drawn through these connections should pass through the center of gravity of the water in the tank). At each connection should be a valve, to which is attached a ½-inch flexible rubber tube, in the other end of which is a glass tube about 12 inches long. A properly graduated scale at these points permits readings to be taken giving at once the weight of water in the tender. These same scales will also serve when testing the meter.

The injector should be put in the best possible working condition, so that but

little water shall pass out the overflow, as this must be caught and deducted from the meter readings.

A meter* to be placed on the discharge pipe is now in the hands of the writer and if found reliable may perhaps be more satisfactory.

Indicator Diagrams.—In the matter of preparation for indication, the writer has perhaps naturally enough followed all of the different schemes as portrayed or advised by other experimenters, but has found that so far the most satisfactory plan for single cylinders is as follows : Tap the cylinders on the sides, and at an angle of 45 degrees, with a horizontal plane ; connect to a three-way cock by using a short nipple at each end with elbows looking toward each other. It may sometimes be necessary to use 45 degree ells looking up, followed by another short nipple and elbow, before connecting to the three-way cock Use ½-inch three-way cocks having union connections at each side, in preference to the kind having a slip joint at one side. Use ¾-inch connections up to the short ½-inch nipples at the three-way cock.

Use a separate indicator on a short connection for steam chest diagrams. Fasten in the handles of the three-way cocks, and carefully wrap the pipes with hair felt or asbestos cord.

The reducing rigging will depend upon the cross-head arrangements. Some form of pantograph will frequently answer, but for high speeds, even above fifty miles per hour, the best thing is a double slotted lever. Run a ⅝-inch rod from the reduced motion slide or pin, back through one or two brackets fastened to the steam chest. Fasten a special "cord bracket" to the ⅝-inch rod and locate this bracket eight or ten inches from the indicator and between it and the operator.

The "cord bracket" referred to above, was designed about three years ago by a student of the senior class of the mechanical engineering department of the University of Illinois, as the result of a competitive design calling for the simplest reliable stop and start motion for driving an indicator on locomotive work. I believe the design fulfills the requirements.

It is shown in Fig. 1. It consists of a cast iron or brass casting, drilled to fit

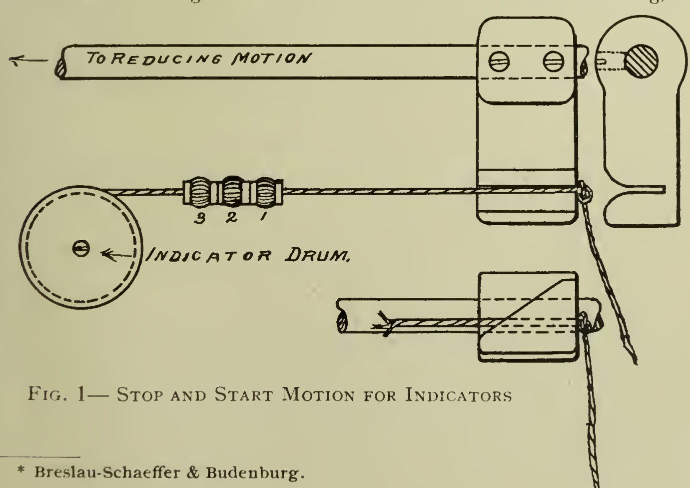

Fig. 1— Stop and Start Motion for Indicators

* Breslau-Schaeffer & Budenburg.

the ⅝-inch driving rod from the reducing motion, and furnished with set screws to fasten it to this rod. It is long enough to reach to the proper driving line for the indicator, at which point it is slotted to easily take the cord, the slot being wider at the top to more easily permit of placing the cord in it. Three light wood buttons ½-inch long are strung on the cord; a knot tied at the proper place permits a pair of diagrams being taken, while three additional diagrams may be taken on the same card by successively having buttons 1, 2 and 3 between the knot and the driving edge of the bracket.

It is assumed that the indicator has a 2-inch drum and that the length of the diagram taken is about 2½ inches. The slack end of the cord is hooked to some convenient point and the operator soon drops the cord into this slot with the greatest ease and certainty, always first pulling the drum up against its stop. When changing a card the cord is hooked to such a point as will bring the clips at the most convenient place for this operation.

Drawbar Pull.—An accurate record of the drawbar pull exerted back of the tender should be made the basis of all locomotive road tests.

The construction of the car referred to above, and the method of recording drawbar pull have been fully described in the various technical journals * and can not be introduced into this paper.

For the benefit of any who may be interested in this matter, I have placed on the table before you several of the original charts showing the records obtained of drawbar pulls over distances of 50 to 100 miles. As these charts are on a scale of 1 inch to 400 feet, it would be impracticable to reproduce them except in sections. I have also added the speed charts obtained from the Boyer recorder, the distance base being about three times the usual amount as used in the standard machine.

From the pull on the drawbar in pounds and the speed of the train in feet per minute, the drawbar horse power is determined for any and all points of the run.

Speed.—Three distinct records of speed are recorded in the car, namely, the record from the Boyer chart, the electric revolution counter which counts revolutions of drivers, and the electric time attachment which automatically marks divisions of time on the drawbar pull chart at intervals of five, ten, twenty, thirty or sixty seconds, as desired.

Mile Posts.—An observer stationed in the tower presses a button when passing mile posts, crossings, bridges or stations, and thus marks on the drawbar charts the localities of these places.

Pressures in Car.—The boiler pressure, steam chest pressure, and vacuum pressure in the smoke box are all indicated, the first and last being recorded in the car.

The actual pressures on the engine are compared with car readings from time to time for purposes of correction. The difference of these pressures is, however, very slight, and the movement of the pointer indicating steam chest pressure is such as suggests that it is directly connected to the throttle lever. It may be advisable to register this record, but as yet this has not been done.

Forms of Blanks.—For the purpose of recording the observations required, the following forms are submitted as used by the Department of Railway

* Railroad Gazette, November 23, 1898.
* See Railway Master Mechanic of June, 1899.

Mechanical Engineering at the University of Illinois; but it will be seen that they would need some changes to be suited to tests where a special car is not available for a part of the work.

Methods of Working.— The writer has perfectly clear recollections of his first ride on a front end, with instructions to take cards at every minute and read the counter at every half minute. At the end of a run of about two and one-half hours, it is doubtful if I had six cards that were of any value. It was an express train and it ran at times sixty miles an hour. I was strapped to the pilot brace and well protected by a wind guard; but my only thought was first to hold on to something, and, second, my feeling of chagrin that I was not getting any cards. On the return trip things went better and it seemed slower; and three trips later I took 144 sets of diagrams in 120 minutes,—three sets taken in a tunnel in absolute darkness.

The possibility of taking diagrams every minute has been demonstrated by several subsequent tests, but to do so more frequently is a matter of difficulty.

It is right at this point that the whole matter of road testing needs help.

Indicator diagrams from the locomotive are useful to exhibit the action of the steam in the cylinders, and should be taken at the various speeds and for the various positions of the reverse lever. There is, however in my opinion no longer any necessity for endeavoring to take a sufficient number of diagrams for determining the average horse power developed. Let the drawbar horse power serve as the basis of comparison. Establish a ratio between the latter and the indicated horse power of the engine. Do this by signaling from the car when diagrams are to be taken. (Press the button and take them from the car is easier written than accomplished.) Frequently a train will run for miles with but slight variation of drawbar pull and at nearly constant speed; under such conditions no diagrams are required. By watching the record of drawbar pull, and speed one soon learns when a diagram should be taken.

By this method a sufficient number of diagrams may be obtained so that a curve of indicated horse power may be laid off above the curve of drawbar horse power and the desired results obtained with even greater accuracy than would be possible by taking a large number of diagrams and working them up This is the method which we have now adopted at the University, and which we believe is worthy of calling to your attention.

Those of you who have worked up 1,200 to 1,400 diagrams for a road test will appreciate the relief it would afford if this work could be reduced 75 per cent, as I believe it can.

The Results.—For purposes of comparison, uniformity is desirable in the method of reporting results. While some improvements might now be made in the scheme proposed in the report of the committee referred to at the beginning of this paper, it has not seemed wise to suggest such changes at this time. I have therefore added the scheme for reporting the results of road tests as proposed by the A. S. M. E. Such other items as may be obtained in any special case should be added under their appropriate heading.

TABLE OF RESULTS.

Data and Results of Road Test on............Engine, made........190..

General dimensions, etc., (to be accompanied by a complete description of engine, with drawings and dimensions, also of train and route).

1.	Kind of engine...............................	
2.	Size of cylinders...............................	
3.	Clearance of cylinders...............................	%
4.	Area of heating surface...............................	sq. ft.
5.	Area of grate surface...............................	sq. ft.
6	Size of exhaust nozzles...............................	inches.
7.	Average weight of locomotive and tender (including water)..	tons.
8.	Number of cars...............................	
9.	Weight of cars...............................	tons.
10.	Length of route...............................	miles.
11.	Number of ton miles of train load...............................	ton miles.
12.	Number of ton miles of total load...............................	ton miles.
13.	Schedule time of trips...............................	

TOTAL QUANTITIES

14.	Duration of time throttle-valve is open...............................	hours.
15.	Weight of dry coal burned...............................	lbs.
16.	Weight of water evaporated corrected for moisture in the steam and loss at injector*...............................	lbs.
17.	Weight of ashes and refuse from ash pan...............................	lbs.
18.	Weight of cinders from smokebox...............................	lbs.
19.	Percentage of ash as found by coal calorimeter test.........	%
20.	Total heat of combustion as found by calorimeter test......	B. T. U.
21.	Results of chemical analysis of coal...............................	

POWER DATA.

22.	Mean effective pressure, H. P. cyls...............................	lbs.
23.	Mean effective pressure, L. P. cyls...............................	lbs.
24.	Average revolutions per minute...............................	rev.
25.	Indicated horse power, H. P. cyls...............................	H. P.
26.	Indicated horse power, L. P. cyls...............................	H. P.
27.	Indicated horse power, whole engine...............................	H. P.
28.	Pull on drawbar...............................	lbs.
29.	Dynamometer horse power...............................	H. P.

AVERAGES OF OBSERVATIONS OF INSTRUMENTS.

30.	Average boiler pressure...............................	lbs.
31.	Average steam chest pressure...............................	lbs.
32.	Average temperature of smokebox...............................	°
33.	Average draught suction...............................	''
34.	Average temperature of feed water...............................	
35.	Average temperature of atmosphere...............................	°

*Should be corrected for steam used by calorimeter, air pump, blower, safety valve and whistle, to find cylinder results—line 56.

36. Average percentage of moisture in the steam............... %
37. Maximum percentage of moisture in the steam............. %
38. Weather, wind, etc...................................

OTHER DATA.

39. Average position of throttle ....
40. Average position of reversing lever...........................
41. Average speed in miles per hour..........................
42. Maximum speed in miles per hour............ ....
43. Number of stops.......................................
44. Average number of strokes of air pump per minute.........
45. Total estimated weight of steam used by air pump per hour. lbs.
46. Estimated loss of steam at safety valve per hour........... lbs.
47. Estimated loss of steam at whistle per hour................ lbs.
48. Estimated weight of steam used by blower per hour........ lbs.
49. Estimated loss of steam at calorimeter per hour .... lbs.

HOURLY QUANTITIES.

50. Weight of dry coal burned per hour...................... lbs.
51. Weight of dry coal burned per hour per square foot of grate surface....................................... lbs.
52. Weight of coal burned per square foot of heating surface... lbs.
53. Weight of water evaporated per hour....... .... lbs.
54. Equivalent weight of water evaporated per hour with feed water at 100° and pressure 70 lbs...................... lbs.
55. Equivalent weight of water from 100° at 70 lbs. evaporated per square foot of heating surface.... .... lbs.
56. Weight of water consumed by engine cylinders (line 53, less sum of lines 45, 46, 47, 48 and 49) .... lbs.

PRINCIPAL RESULTS—COMPLETE ENGINE AND BOILER.

57. Coal consumed per I. H. P. per hour .... lbs.
58. Coal consumed per dynamometer horse power per hour..... lbs.
59. Coal consumed per ton mile of train load. .... lbs.
60. Coal consumed per ton mile of total load ... . lbs.
61. Weight of standard coal consumed per I. H. P. per hour.... lbs.
62. Weight of standard coal consumed per dynamometer horse power per hour..................... .... lbs.
63. Weight of standard coal consumed per ton mile of train load lbs.
64. Weight of standard coal consumed per ton mile of total load lbs.

BOILER RESULTS.

65. Water evaporated per pound of coal..................... lbs.
66. Equivalent evaporation per pound of coal from and at 212° lbs.
67. Equivalent evaporation per pound of combustible from and at 212°... lbs.

CYLINDER DATA.

68. Mean initial pressure above atmosphere....... .... lbs.

		H. P. Cyl.	L. P. Cyl.
69. Cut-off pressure above zero..................	lbs.		
70. Release pressure above zero..................	lbs.		
71. Compression pressure above zero..............	lbs.		
72. Lowest back pressure above or below atmosphere..........................	lbs.		
73. Proportion of forward stroke completed at cut-off	lbs.		
74. Proportion of forward stroke completed at release..................................			
75. Proportion of return stroke uncompleted at compression................................			
76. Mean effective pressure (lines 22 and 23)........	lbs.		

CYLINDER RESULTS.

77. Total water consumed per indicated horse power per hour corrected for moisture in steam.................... . lbs.

78. Water consumed per I. H. P. per hour by cylinders alone (from line 56).. lbs.

		H. P. Cyl.	L. P. Cyl.
79. Steam accounted for by indicators at cut-off.....	lbs.		
80. Steam accounted for by indicator at release.....	lbs.		
81. Proportion of feed water used by cylinders (line 78) accounted for at cut-off.............			
82. Proportion of feed water used by cylinders accounted for at release............................			

Considering the amount of labor involved in making and working up locomotive road tests, it would always seem desirable to make tests with an engine whose boiler is known to be reasonably free from scale.

No attempt at testing should be made without the co-operation and assistance of the "road foreman of engines," so as to insure the operation of the locomotive under approved conditions.

It will not be necessary to repeat in this paper the many excellent precautions and directions given in the paper referred to before in this article. There are many experienced railroad men who do not believe that road tests should be made at all. It has not been my object to prove that they should be made. There are, however, others that realize the importance of "road tests" for the determination of some features of engine performance, and especially for comparisons as between different types of engines in actual service conditions.

I am not a believer in "road tests" when it comes to trying this or that device on an engine as a fuel saver. "Painting the smokestack red" has frequently been shown (?) to save 10 per cent of the fuel.

If "road tests" could be made more accurate and with less labor before a test, during a test, and after a test, it has seemed possible that they would be worth making.

It has been with a desire to indicate what seems to the writer a help in this direction that this paper has been written.

SAMPLES OF BLANKS.

DEPARTMENT RAILWAY MECHANICAL ENGINEERING.

UNIVERSITY OF ILLINOIS.

COAL SHEET.

Log for Locomotive Road Tests.

Test No. .... *Locomotive No.* .... *Date* ....

Items.	At the Beginning of Test.	Taken on During Run.	At the End of Test.
Weight of bulk coal in tender			
Number of bags containing 100 pounds			
Total weight tender with coal and water			
Height of water in tender			
Total weight coal consumed			
Weight of ashes from ash pan			
Weight of cinders from smokebox			

DEPARTMENT RAILWAY MECHANICAL ENGINEERING.

UNIVERSITY OF ILLINOIS.

FEED WATER

Log for Locomotive Road Tests.

Test No. .... *Locomotive No.* .... *Date* ....

Time.	Water Meter Readi'gs Cubic Ft.	Height of Water in Inches on Tender Gage.		Temper'ture of Feed Water.	Location of Train.	Injector Overflow Estimat'd in Pounds.	Remarks.
		Front.	Back.				

DEPARTMENT RAILWAY MECHANICAL ENGINEERING.

UNIVERSITY OF ILLINOIS.

CAB RECORD

Log for Locomotive Road Tests.

Test No. .... *Locomotive No.* .... *Date* ....

Time.	Height of Water in Boiler. Inches on Glass.	Blower on from to	Position of		Calorimeter Data.			Remarks.
			Lever.	Throttle				
......	....	....	......	....	...	..	...	....
......	....	....	.....	....	...	...	...	....
......	....	....	......	....	...	...	.	....

DEPARTMENT RAILWAY MECHANICAL ENGINEERING.

UNIVERSITY OF ILLINOIS.

FRONT END.

Log for Locomotive Road Tests.

Test No. .... *Locomotive No.* .... *Date* ....

Time.	Smokebox Vacuum in Inches of Water.	Temper'ture of Escaping Gases.	Strokes of Air Pump Counter Reading.	Extra Column.	Remarks.
......	....	....	....	....	....
.....	....	....	....	....	....
......	....	....	....	....	....

DEPARTMENT RAILWAY MECHANICAL ENGINEERING.

UNIVERSITY OF ILLINOIS.

CAR SHEET NO. 1.

Log for Locomotive Road Tests.

Test No. .... *Locomotive No.* .... *Date* ....

Time.	Pressures by Gage on		Revs. of Drivers Counter Reading.	Speed in Miles Per Hour by Boyer Gage.		Remarks.
	Boiler.	Steam Chest.				
......	......	.....	....	....	....	....
......	.....	......	....	....	....	....
.....	......	.....	....	....	....	....

DEPARTMENT RAILWAY MECHANICAL ENGINEERING.

UNIVERSITY OF ILLINOIS.

CAR SHEET NO. 2.

Log for Locomotive Road Tests.

Test No. .... *Locomotive No.* .... *Date* ....

GENERAL INFORMATION.

1. Date and duration of test. ....
2. List of observers.................................. ....
   ....
3. List of train crew..
4. Character and number of train.... ....
   ....
5. Number of times whistle blows.. .....
6. Length of time safety valve blows..
7. Amount of oil used... .. ..
8. Wind, weather and rail condition................... ....
   ....
   ....
9. Moisture of coal.................... ....
10. Description of coal....... ....
11. ....
12. ....
13. ....
14. ....
15. ....
16. ....
17. ....

Prof. L. P. Breckenridge (University of Illinois): Mr. President, and members of the Western Railway Club. I think that very little need be said in opening this paper; I said about all that needs to be said in the paper, as far as anything new is concerned, and repeated a good many things with which most of us are familiar.

I may say that I have placed on the table three exhibits. The two long rolls across the table are exhibitions of diagrams of records taken from drawbar pulls in the car which we are now operating on the Big Four road. The blue prints are drawings which explain, in a manner, the construction of the car, the photographs recently taken, showing the apparatus for recording the drawbar pull.

The drawings at the end of the table exhibit the proposed construction which we shall put into the Illinois Central car, which is now ready, at the Burnside shops, for our apparatus.

I may say, briefly, that the interest of the University of Illinois in the dynamometer cars has grown upon us, one way and another, and we find ourselves pretty well swamped with troubles and trials relating to dynamometer cars. We enjoy it in good measure, but at the same time I feel like apologizing to the railway clubs for not having by this time more information to give that is worth something. This year has really been with us a year of construction, because of the new design we have had to bring out, and also numerous changes in the apparatus which we had already used.

This whole matter has come to us, I may say, on account of the fact that we took up and carried out, in 1897, a series of locomotive road tests on the Illinois Central Railroad, and the reports of those tests are exhibited on the table. The magnitude of the undertaking, the actual working up of all the indicator diagrams and getting the work in satisfactory shape for sixteen locomotive road tests, was something appalling, taking cards as we did, once every minute, which means four diagrams a minute. The difficulties and the work of getting that report in shape is really the excuse which we offer for trying, in some measure, to obviate that work, and in trying to record, autographically, some of these things in a car attached to the locomotive rather than trying to get these records in the usual way—taking the indicator diagrams very frequently and working them up as a basis for report.

I ought, perhaps, to call attention on page 2 to the items 8 and 9, "Position of Throttle Valve" and "Position of Reversing Lever." I

said in this paper that the items indicated with the star were recorded in the dynamometer car. I may say this paper has been written about six weeks, and I expected by the time that it was read that that might be so. It is not yet so; we have designed this apparatus, but it is not yet in the dynamometer car. I think, perhaps, it might be allowed to stand, as I think it will not be long before it is true.

There may be, I hope, some queries in connection with this paper that I shall be able to answer, but if there are none, why, I present this paper to you with a great deal of pleasure, hoping that it may serve in some way those of you who happen to be interested in the subject of economizing time and labor when it is desirable to make any sort of locomotive road tests.

President Hetzler: Gentlemen, this is a subject which is of interest to nearly every one of our members, and I hope Prof. Breckenridge's paper will be thoroughly discussed. Discussion is in order. Mr. Sinclair, will you open the discussion?

Mr. Angus Sinclair (*Locomotive Engineering*): I am so seldom present at the meetings of the Western Railway Club that I feel diffident, to some extent, in getting up among you to speak.

I am not particularly in sympathy with the paper which has just been read before us. I have seen a great many road tests of locomotives and taken part in a great many, and I think that there is no necessity for the elaboration which certain parties wish to make in connection with those tests. There are a few simple things which ought to be known. You want to know if the distribution of the steam is what it ought to be; you want to know the temperature of the gases that are passing into the smokebox, and practically the character of the steam—if the steam is wet or dry. After that, all the other things given are just mere elaborations that might just as well be wiped off.

On reading the paper I notice there is one very important thing omitted; that is, the flow of gases in the smokebox. In many engines, I believe, the draft appliances are so badly arranged that the gases do not pass through the tubes uniformly; that is, there will be a rush of gas above or below, or in the middle, and certain tubes are not getting used at all. I think to ascertain that would be much better and more practical for use than nearly all the other things that are recommended in that paper.

Another thing about locomotive tests is, there is a strong tendency

to take indicator diagrams from high class working engines and make elaborate tests, while engines that are in miserable condition, engines that will not pull two-thirds of the train that they originally ought to pull, are left untested. These are the engines to which the indicator ought to be applied and the result of their degeneration told to the world. I have seen, in fact I have some indicator diagram tests taken from a locomotive on a certain road, where the full initial pressure was not received until over one-third of the stroke had passed, and they thought the engine worked very well, too. She was square, and they could not see that there was any other indication that the engine was not doing as well as she ever had done. They indicated the cylinders, then adjusted the valves so that there was full initial pressure at the beginning of the stroke, and it resulted in a very material saving of fuel, and that is the lesson you are to get from applying the indicator where it ought to be applied, and that is to worn-out engines.

Prof. W. F. M. Goss (Purdue University): I am glad Prof. Breckenridge has presented this paper. If anyone knows anything about road tests of engines it is one actively engaged in the work of such tests, and the Club is fortunate in having this paper from Prof. Breckenridge who is fresh from the field.

It is well to note that the general subject of testing locomotives on the road has been treated by a joint committee of the Master Mechanics' Association and of the American Society of Mechanical Engineers. The paper under discussion is not, as I understand it, at variance with the general recommendation of this joint committee, but supplementary thereto. It shows how certain things can be done to increase the facility with which observations may be made. To this end a considerable amount of apparatus employed to interpret the action of various parts of the machine, and hitherto attached directly to the locomotive itself, are brought back to a dynamometer car. Thus, steam gauges, vacuum gauges and things of a similar sort are made a permanent part of the car, an arrangement giving room for a considerable number of observers, and increasing their comfort. Such a plan is an attractive one, but it adds considerable mechanism to the experimental plant. From a scientific point of view, it is a question whether after all it presents a real gain. Many engineers, when they want to find out what is going on in any particular portion of any complicated machine, prefer putting their instruments of observation just as near as possible to the portion of the apparatus to be

studied. A gauge to show boiler pressure should, for experimental purposes, be on the boiler not many feet away with a long and crooked pipe connection, because such a pipe becomes an intervening piece of apparatus, and as such requires attention which would be saved if the pipe did not exist.

When in Paris, recently, I had the privilege of inspecting two locomotives of the Eastern Railroad of France, which were being fitted for a test. Mr. Salomon, under whose direction the work was being done, had met the problem which Professor Breckenridge has so well solved by the use of a dynamometer car, in quite another way. The new engines were both single expansion, but were different in wheel arrangement and in other details. In preparation for testing, the cab of these engines had been extended forward above the running board on one side, clear to the front of the smokebox. The front end was closed by a good sized door. This extended cab served to house all the instruments, including indicators, and gave a roomy apartment for observers.

The precise arrangement of apparatus, in any case, must always depend upon what it is desired to find out. If we want to know something about steam distribution, we expect to go to the indicator; if we are interested in knowing what an engine will pull, the dynamometer car is perhaps sufficient. I am not certain but there would be positive gain if we would check off the problems as suggested by Mr. Sinclair and eliminate first one and then another.

In the matter of boiler performance, for example, we know from work already published in the proceedings of our Club that the performance of a locomotive boiler can be defined with great accuracy from tests made while the engine is at rest. After a few tests under suitably selected conditions, a characteristic curve can be plotted, from which it can always be known how much steam is being made per pound of coal, when the power to which the boiler is worked is known. With the problem of testing locomotives given, why not begin with the boiler? With all complications involved in determining boiler performance effectually eliminated, one may enter upon a road test of a locomotive with fair promise of success.

Now, Mr. President, I have to apologize in making these remarks. I never made a road test and I do not know very much about it, but I have read Prof. Breckenridge's paper with a great deal of interest,

and the suggestions I have offered are some of those which occur to me as I read.

In this connection, I may be permitted a single reference to shop tests which, while generally approved in this country, are not being followed to any considerable extent. I was interested, when abroad, to notice that at the Hartmann Locomotive Works in Chemnitz, Germany, provision is being made for the establishment of testing plants, and, again, that at the Ephaney shops of the Eastern Railroad of France experiments were being made on friction brakes, looking to the establishment of a testing plant. I regret that I do not know of any such movement now in progress by the railways of this country.

Mr. William Forsyth : There are two questions I would like to ask Prof. Breckenridge. First, whether I understood that he had anything which would be an equivalent to a continuous indicator card ; second, whether in connection with the dynamometer car they had determined the amount of friction of the cupped leather in hydraulic piston, and whether it had been calibrated at all, so as to know how accurate its work was.

Prof. Breckenridge : In regard to the question of continuous indicator, I have made some notes on it here, thinking it might come up. I can only say that when any one gets started in a dynamometer car and tries to put a few things in, he pretty nearly gets everything into it by and by, and the department has ordered a continuous indicator which is being made in the hopes that it may serve some useful purpose in this connection. The indicator which has been ordered is the kind that was brought out by Prof. C. S. Brown, of Vanderbilt University, in connection with Prof. Gray, of Terre Haute, and those indicators have been promised for two or three months, but difficulties of manufacture have interfered with their delivery, and the result is that we have not yet had an opportunity to try them. You will notice in the body of the paper that I state somewhere in parenthesis, "(Press the button and take them from the car is easier written than accomplished)." I put that in there because I thought that probably some time it might be possible to press a button in the dynamometer car and take indicator cards. Whether or not it will be so I can not say, because I have not had a chance to experiment with continuous indicators.

I have seen continuous indicator diagrams taken over seventy-five miles of road. Of course the cards are different from the others in

that the back pressure is not under the forward pressure as the paper is always moving ahead.

The question of calibration of dynamometer apparatus is a question which we have taken up more particularly with our new construction, and are arranging to put it in the testing machine before we put it on the car. We have never been able to devise an entirely satisfactory scheme for calibrating the dynamometer that is already on the car, although we have now some ideas of holding the car on the track and pumping oil into our cylinder and letting it press down on a pair of track scales in order that we may get an accurate calibration curve. I may say, however, that experiments have been made with cylinders with cup leathers up to a thousand pounds by Prof. Johnson, now dean of the College of Mechanics and Engineering at Madison, Wisconsin, and I understand that up to five or six hundred pounds pressure the frictional resistance of apparatus of this kind has not been found to exceed 3 or 4 per cent.

Prof. Flather, now of the University of Minnesota, has a student engaged in a similar line of investigation in his thesis work. I am told he finds the frictional resistance to be small, when the pressure does not exceed six or seven hundred pounds per square inch.

In the operation of the recording pencil, I think any one of you that has ever watched our apparatus work, will agree that it is extremely sensitive to any change that goes on. You can watch the recording pencil and also the engineer in the cab, and the slightest motion of his hand on the throttle lever shows a change in the drawbar pull, and the fact that the gauge pointer has that little swinging motion to it, all the way, which is indicative of freedom of action rather than any sudden jerking motion which you are familiar with as indicating frictional difficulties, is some proof to me that the frictional resistances are not large. However, in future constructions we will try the experiment of still further eliminating what may be frictional resistance by throwing out cup leather arrangements and putting in bronze for pistons, carefully ground and lapped in the cylinder.

Prof. Goss: Prof. Breckenridge, with his customary frankness, makes a statement on page 10 that is a little hard to understand. In connection with the purpose of the paper, he says: "If 'road tests' could be made more accurate and with less labor before a test, during

a test and after a test, it has seemed possible that they would be worth making."

The statement seems to array itself against the purpose of the paper and I did not understand it.

Prof. Breckenridge: What I tried to make it mean was this: I have exhibited on the table a series of locomotive road tests made on what I have chosen to call the old method of basing results on a large number of indicator cards to be taken from the locomotive, as against the plan which I propose, of making everything depend on drawbar pull and only taking cards once in a while, and what I tried to indicate here is that the scheme which I propose is a scheme which is easier and more accurate. If I failed to make the point plain in the paper, I hope I have now.

Prof. Goss: I do not wish to be the means of bringing the discussion down to minor details, but desire to say with reference to cup leathers that the experience of a great many years has proven them to be quite unreliable when employed as a part of a weighing machine. In some tests which I have witnessed it was found that everything depended on the condition of the leather. If the leather was stiff, the friction was small and the leakage great, while if the leather was soft, the leakage was small and the friction great. As Prof. Johnson's work with cup leathers has been referred to, I am compelled to say that even Prof. Johnson did not escape severe criticism for the degree of confidence he bestowed upon them. I remember, also, that in a discussion of the question, he admitted that the frictional resistance of the leather was assumed to be constant for all pressures, the correction being, I believe, 500 pounds which was added to the registered load of his machine. I think, therefore, that Prof. Breckenridge has made a great gain in eliminating cup leather from his new apparatus.

Prof. C. V. Kerr (Armour Institute of Technology): One remark made by Prof. Goss, a few minutes ago, prompted this query in my mind. He spoke of the elimination of the boiler test from the road test, and also the cylinder test. This statement, I have seen, to the effect that the locomotive boiler will not perform the same when used as a stationary boiler as it will on the road. Where I saw the statement there was no explanation and it remains to be conjectured what it was. It seems to me it is primarily a difference in the circulation of the water in the boiler as affected by the rolling and jarring

of the engine. That view of it would rather seriously interfere with dropping out the boiler test from the road tests. The cylinder performance would probably be affected very little, if at all, in that way.

PROF. GOSS : That question has been up before another railway club during the present winter, and I would like now to repeat some things bearing upon it which I have said before this Club. About two years ago, the Club enjoyed a paper by Mr. William Garstang, reporting results of tests of different fuels which were made upon the Purdue locomotive plant. In outlining these tests, Mr. Garstang considered it imperative that the engine should be in motion, and all of his tests were so run. Before these tests and, also, after their completion, other tests were run, in the course of which draft was made by blocking up the valves and opening the throttle. Comparisons show identical results. The draft is the governor. If you burn the fuel you get the steam. The motion of the boiler has no effect. I can say advisedly that there is nothing in the "vibration theory."

MR. SINCLAIR : I am very much pleased to hear what Prof. Goss has said on that subject. I heard a statement made in the American Society of Mechanical Engineers that the locomotive boiler could not be made to steam as freely when acting, as a stationary boiler ; that is, when used as a locomotive boiler. I took the statement under consideration and gave it a great deal of thought, and it was my intention, at the first opportunity I had to come out west to Purdue University, to find out what their experience has been with the steaming capacity of their engines as compared with the steaming on the road, and I am glad to hear that the case is settled. There are some people who will get up and make strange statements without any foundation to them, and there is no doubt but that statement was one of the kind.

If the theory on which he appeared to base his statement were true, a rough riding engine would always steam better than an easy riding engine, and an engine bumping over a rough track would steam better than one going over a smooth track ; consequently, I think it is a good thing if this is settled, for the next thing you might see would be people letting the track run down for the benefit of the steaming of the locomotive, and getting heavy springs to make the engines ride rough so they would use less coal in pulling trains.

MR. SINCLAIR : I rise to make a correction. Prof. Goss informs me that the statement to which I referred was made at the New York

Railway Club. I am rather inclined to save the reputation of the New York Railway Club as well as I can, but I do not want to save it at the expense of the American Society of Mechanical Engineers.

Mr. A. E. Manchester (C., M. & St. P. Ry.): The question of locomotive tests is, perhaps, important, but not all important in connection with dynamometer tests on railroads, but if more attention were given to the very important conditions that might be determined by the dynamometer outside of the engine, I believe it would be a good thing for the railroads and perhaps give much needed information. For example, in dynamometer tests that I have seen, they have often shown up a condition in the track that the engineering department was entirely unaware of. The profile in the engineer's office would show that some time thirty years ago, the railroad had been built and put up under certain conditions, but since that time there has been graveling and work constantly going on that had changed the general contour of the surface of the road, and of the curves and the stalling of trains is often due to that particular condition. One of the purposes of the dynamometer car should be to help to detect these errors as well as those in the locomotive. Then, there is also the question of side bearings and the different kinds of trucks. I believe that one of the items of information that would be of great interest to railroads and mechanical people would be to have it determined what effect side bearings are having on the draft of the train, and whether or not there is any difference in the differently constructed trucks, whether the swing motion truck or the rigid truck have any merits so far as their hauling easily or hard is concerned.

In looking over the drawbar pull, as I understand it, from the diagrams on the table, I notice that there is but a very slight variation in the pencil, that the variations due to the revolving variations of pressure are almost eliminated. It has occurred to me that that is not a good thing to do; that one of the things that might be read from the dynamometer car would be to have the pencil arms so flexible that any inequality in the revolving strength developed would be shown upon the card and shown in sufficiently marked form to have it very noticeable. In watching some tests, not long ago, that was very plainly brought to my notice. An engine, under a certain condition, showed a very lively vibration, and by some decided improvements that were made in it afterward, the line was brought down to

nearly a straight line under the same conditions and in the same character of service and speeds.

Mr. F. A. Delano (C., B. & Q. R. R.): Mr. Chairman, and gentlemen: I feel very much indebted to Prof. Breckenridge for furnishing us this paper, but I think the members would be even more indebted if he should be disposed to publish some of the photographs that he has exhibited on the table. We have all heard that Prof. Breckenridge has been working on this subject, and we have always been eager for the information that he has given us in part here. I can say, too, that I am happy in being able to agree with all the speakers, both Prof. Breckenridge and Mr. Sinclair. It seems to me that for a dynamometer car, and in fact a car that also aims to accomplish a great deal more,—for example, track inspection, dynograph work, etc.,—that this car of Prof. Breckenridge is none too elaborate; where great accuracy of work is required and wanted, we cannot have our instruments any too precise, but I also agree with Mr. Sinclair that there is great need of simplifying engine tests and road tests so that they can be made more frequently, and for all classes and conditions of engines. As he very truly points out, it is not the newly built engines or the special engines which require testing, nearly as much as the average engines in ordinary condition.

There is a great deal of energy and thought expended on the newer types of engines, while the old types of engines are much more numerous and hence are burning up the coal and costing the money. Now, in stationary practice we have, in almost all boiler rooms or large boiler plants, automatic recording gauges which make a diagram showing what has been done in twenty-four hours, and I have great hopes that the time will come when we can have something as simple for our locomotives, something that we can put on the tender drawbar of an engine and get the record of what the engine is doing over a division of the road. Of course, for such mechanism as that we would not expect the accuracy that we would want or expect in a dynamometer car. Any suggestion that will simplify and cheapen the cost of getting indicator cards and working up the data from them will, as Prof. Breckenridge has said, be a great help to us.

I have been told, for instance, that it is the practice of some builders of stationary engines to indicate every one of their engines before they send them out. Now, if that is done on an engine that has cost a few hundred dollars, or even a thousand dollars, why is

there not vastly more reason for doing it in the case of locomotives which cost several thousand dollars, and yet what a very small proportion of all the locomotives that are on our railroads have ever been indicated. We hear them wheezing and making odd noises but we do not find out just what it is that causes them. We know that engines built after precisely the same designs vary a great deal, and yet we do not run the thing down. I suppose one reason is that indicator tests and dynamometer tests cost a great deal of money and take a great deal of time and very careful work.

Mr. E. E. Russell Tratman (*Engineering News*) : I think that what has been said this afternoon shows that there are two features to be considered in these locomotive tests. First, the test of the engine as a machine, independent of its service ; and, second, the test under the conditions under which it is worked in actual service. It seems to me that you cannot combine these two very well. The indicator diagrams are the best way, probably, of ascertaining the actual efficiency of the engine, and I doubt if you can ascertain that as well by the drawbar system. But the indicator diagrams do not show so well the condition that the engine is working under. If the dynamometer diagrams show the condition of the track and the condition of the trains as affected by the side bearings, or the style of trucks that are being used, that is quite independent of the efficiency of the engine under test, and it seems to me the two systems must be used for a complete test of what you might call the train performance of the engine. Thus, defective performance or insufficient power may be due (1) to conditions in the engine itself, such as badly set slide valves or faulty front end design ; or (2) it may be due to conditions of the roadbed, such as excessive and irregular grades due to surfacing or raising track, or a generally weak construction of track which deflects under the traffic ; or (3) it may be due to conditions in the train itself, such as different forms of side bearings or trucks. The latter two causes cannot be included in shop tests, nor will they be shown by indicator cards taken on the road. The indicator cards show the conditions within the engine, while the dynamometer cards show the conditions outside of the engine. I believe that simple tests of a number of engines will be of more practical value to the railway than more elaborate tests of a few engines.

Mr. M. H. Wickhorst (C., B. & Q. R. R.) : I have no particular remarks to make, except that I have been largely engaged in the

work of testing, and what I wish is more particularly to express my sincere thanks to Prof. Breckenridge for presenting this paper to us, so that I will always have his opinions where I can get at them for reference.

Prof. Goss : With reference to the suggestions of Mr. Delano, that there be incorporated in this paper some illustrations of the dynamometer car, I will call attention to the fact that this paper concerns locomotive tests and the dynamometer car is mentioned incidentally only. For this reason, I think a better plan for the Club would be to urge upon Prof. Breckenridge its desire to have him present as a separate paper a description of his dynamometer car, with results obtained therefrom, as early as practicable. I certainly hope that he will consent to serve us in this way.

President Hetzler : If there are no further remarks, I will ask Prof. Breckenridge to close the discussion.

Prof. Breckenridge : I am very grateful to all of you who have expressed any sort of an opinion. I am interested in this subject as a professor of mechanical engineering, and my object has been to bring out, if possible, something that may be of some value to railway interests.

I realize that it is a pretty difficult work to do this alone, and I may say that we have not been working entirely alone. We have had help from various individuals in this matter, who have been connected with railroad interests all over the country, and I bring this paper to you that you may tear it all to pieces.

I realize that some of you have never read the paper. After you have read the paper you will see that your remarks have been answered in the paper and it will not be necessary to take up the time to reply in detail to such remarks. I said in one place (I did not know Mr. Sinclair would be here, but I am glad that he is ; I put in this sentence here, thinking of him, not expecting that he would be here): "There are many experienced railroad men who do not believe that road tests shoud be made at all." I actually thought of Mr. Sinclair when I wrote that sentence. I did so because I have watched his remarks for a good many years with interest and I knew what he thought about it all the time, and it has not been my object to prove that road tests should be made, but if any one has any reason or cause to make them, here are some suggestions.

I had made a note here on one subject, however, which Mr. Sin-

clair brought up, that is, relating to the temperature of the escaping gases. In making these tests from time to time we run onto things that we are not looking for. Although you attack a problem and try to investigate it, you frequently are not able to solve it, but you run on to a lot of other facts that, incidentally, will help you to solve other problems or throw some light on the subject so that you may know how to go at them. The temperature of escaping gases in the front end of locomotives, I should like to have somebody tell us how to get, if anybody knows. I have tried nearly all the schemes I have heard of and I have some more schemes I am going to try, but whether they are good for anything I am not sure; they certainly vary from one to two hundred degrees, depending on the conditions. It is an item of absolutely no value to report, that the *average* temperature is six hundred degrees. The question of determining the temperature of gases in the front end I have begun to believe is not of such importance as the determination of the temperature of the gases in the top and bottom rows of tubes; you put considerable money into the heating surface of flues in order to make steam.

Now, you probably are more familiar than I am with a great many changes that occur in front end construction, high and low tips, inside pipes, all sorts of diaphragms and screens, and I cannot even tell the names of the things that are in there, but every man that I meet has got a scheme that he says is the best thing in the world. This is evidence to me that really all these people have cut and tried on that particular locomotive and got it up to the best point possible. It is evidence, also, that the heating surface in the flues of the locomotive is not utilized uniformly to the best advantage. A slight change in the diaphragm construction in the front end which would almost seem ridiculous, determines whether a locomotive makes steam, or whether it does not make steam. All this means that you force your escaping gases through the tubes unequally and make the different rows of tubes perform a valuable service in transmitting heat. It seems to me that the determination of the temperature of the escaping gases in the different tubes, high and low, under ordinary conditions, would be as valuable information as to get the average front end temperature. I have not been able to do this, although I have given the subject considerable thought. At the University, Prof. Carmen, of the Department of Physics, has recently experimented with two or three different types of pyrometers. Among

these is the Le Chatilier pyrometer, and he is experimenting with these under different conditions of heat in order to see how accurately he can record high temperatures by the deflection of the galvanometers. You see what I am trying to get at is the temperature of escaping gases recorded back in the car.

I mention this because Mr. Sinclair is interested in it, and while we went into this without knowing very much about it, we have run up against several difficulties, and have not reached anything very satisfactory; but that is one problem we have in hand.

The question of continuous indicators I have spoken about.

Prof. Goss speaks of the location of apparatus. It is a question of accuracy in the car as against on the engine. I think that he knows that I know that you cannot take indicator diagrams by putting the indicator in the car. He knows that I will not read a steam gauge in the car and read it ten pounds below boiler pressure gauge without knowing what I am doing. The fact is, that we have instruments located in our car which are piped with ¼-inch piping to the steam chest and to the boiler. In making the tests, these two gauges are side by side; the same pipes can be thrown into connection so as to record on a recording chart either of two pressures. A man stationed at the boiler reads the boiler gauge and at the steam chest takes indicator diagrams from the steam chest, and by comparison with the readings taken at the boiler gauge and in the car, we have been much pleased to see very small differences in the pressure. Of course, this is a static pressure. There is no flow of steam through these pipes. We get almost a constant indication on a gauge which is attached to the steam chest pressure, although the indicator takes a card from the steam chest which varies sometimes six or eight pounds; the gauge seems to just about average that pressure. I think we have doubtless discussed some points that we look at as unimportant. Sometimes I am inclined to think that we do not know exactly what you would like to find out, and this sort of discussion, these criticisms and these suggestions, are all helpful to us in carrying our thought along channels that may be of some service to you later.

The question of drawbar pull comes up through Mr. Manchester, and the question of how much it varies. Now, we have two different gauges, one a high pressure gauge and one a low pressure, and we must use the one that we think best in any particular test; for instance,

we have a gauge that will record 1,000 pounds per square inch, and one that will record 300 pounds, and we can throw either one in if it is desirable for getting a larger variation for recording a particular feature. I may say that on slow speed tests made with drawbar pull apparatus, poor valve setting is indicated in the drawbar pull. You can just as surely tell that the valves are not set square by the card that you get on the drawbar pull as can be. Now, that is not as evident as on indicator cards, of course; and it is only at very slow speeds and at speeds in which we have the paper geared up to run rapidly in order to extend our observations over a longer distance. I will say, the paper is run thirteen and two-tenths (13.2) inches to the mile. We can gear it up to double that speed and get 26.4 inches, which gives us rather a long chart, and that is only used where we make drawbar pull tests for steep grades.

Concerning the question of presenting the dynamometer car side of this subject, I should be glad to do so. I indicated some time ago, I think, the desirability of more results which we should get together on this subject, and I realize that we have not been able to do as much as we have planned. We have not the resources of a railroad corporation at hand. All of this work costs money, and we have not got as much money as some of the railroads have, although you in your different departments may find it as difficult to get hold of money that you think you must have in order to keep the railroad from falling to pieces, as we do at the University for keeping up our departments.

We have already agreed with some of the technical papers to give them these photographs, to which Mr. Delano has called attention, for publication, and it is our wish to present anything that we are able to as soon as it is suitable for publication, and to turn it over for criticism or for any use that anybody can make of it. It may be that it would be wiser not to be quite so fast with our information, because we have to take a good many things back sometimes. I suppose that is the reason why railroad men have become a little careful about saying "we find so and so," because probably somebody else has got just as much evidence that it is not so, and they get up and say that the other fellow is all wrong. I am inclined to think that perhaps that is excuse enough for roads that have dynamometer cars not saying much about them; they prefer to use them to their own advantage and not get into trouble a little later.

Mr. Sinclair: I think I may have misunderstood some remarks of Prof. Breckenridge when he was talking about my ideas relating to road tests of locomotives. Am I correct in thinking that you said I was opposed to road tests on locomotives?

Prof. Breckenridge: I understood that the gentleman thought we were undertaking to do altogether too much in making locomotive road tests; that a few of the things which I have mentioned would be sufficient. I realize as well as any one that this paper contains, of course, all the things that you can think of doing or that any fellow ever thought doing in the way of locomotive road tests, because if I had not presented them all some one would say, "Why did you not do that? why did you not do this?" At the same time, in making locomotive road tests for special objects we do have that object in view, and 50 per cent of these things are left out in certain cases. This car, which has been described, we have had perhaps two years, and I suspect that 75 per cent of the time it has been used in dynamometer work rather than locomotive road tests. I do not think locomotive road tests are perhaps as necessary just now as dynamometer tests.

We have on our list of experiments the question of side bearings. We have promises from certain roads that they will equip trains, that they will give us trains, made up entirely of certain side bearings, in order to compare these trains with cars of a different character, loaded with the same loadings; we have also arranged for dynamometer tests of cars carrying large loads and cars carrying small loads —a question of capacity of car. I think locomotive road tests are bound to be more useful just to that particular division and section in a certain locality than they can be to the whole railroad world. I might make all the road tests I would ever think of making, and all on one road, still they might not be of great value to all roads, but they might be of much value to the road on which they were made.

Mr. Sinclair: Can I have a few minutes to put myself right? I am certainly sorry if I gave the impression that I was opposed to road tests; in fact, I am very much in favor of them, but what I object to in the operations that are recommended by the various parties for making the tests, is, that it makes the tests so difficult to carry out that they are not done at all. What we need is just a few simple things to be found out, such as two or three men can get at for the company, so that the engines can be attended to any way that the indications of the tests show to be necessary.

I was once in a great difficulty with a locomotive that would have been very quickly overcome if I had had the means of indicating it, and it was just the kind of a case which I think every railroad in the country ought to get indications when something is found wrong with the locomotive. An engine that I had been running—and it was a very pretty steaming engine—was taken into the shop for a general overhauling, and when she came out she did not steam. I did everything in the world—everything that our experienced men had tried—to make the engine steam; I tried, naturally, the draft appliance first and then everything else but it would not steam, and it was not the same engine as it was before. I went out on it myself and ran it and tried everything, but it was an entire mystery. The difficulty was with the engine, and it was a worry and distress to me all the time. Every time the engine came in it was complained about as not steaming. I was constantly cogitating about what could possibly be the cause of it; accidentally, I thought of trying the striking points of the pistons and there discovered the difficulty. It happened that when she got back into the shop she got the pistons an inch and a quarter thinner than the old ones, and she was not steaming because she was wasting the steam by the immense clearance space. If I had had an indicator put on that engine I should have found out immediately what the trouble was, and could have saved a great deal of worry and delay. It is in these things that I consider the indicator ought to be used in locomotive service.

Prof. Goss: I suppose the discussion is closed and presume I am out of order in rising again. Professor Breckenridge certainly has a right to the last word, and in order that mine may not be the last, I will promise to end by asking him a question.

There are two points upon which I feel that I am not entirely understood. As to the use of the dynamometer car for the reception of instruments of observation, I would say that it is my understanding that the instruments are brought back to the car to give greater facilities in securing data. The question I raise is whether or not the plan does not involve so much care in checking gauges and in looking after the additional apparatus that the expected gain is neutralized?

With reference to smokebox temperature, I will say we have employed a thermopile and galvanometer in connection with the Purdue locomotive for five years or more, by use of which we have secured a large amount of data which we think is entirely reliable. But with us

the observation end of the apparatus, the galvanometer, is in the laboratory secured to a heavy brick wall and, therefore, perfectly stable. The question I have to ask Prof. Breckenridge is, whether he expects to be able to use a delicate galvanometer under the vibrating conditions of the railway car?

Prof. Breckenridge: I suppose I will have to say something on it, whether I want to or not. Locomotive road tests are hard things to make, and it is about as hard to read a paper as to make a test.

Prof. Goss: You said you were going to use a galvanometer in determining smoke box temperatures.

Prof. Breckenridge: Prof. Goss says he has never used a dynamometer car in a locomotive test, and I have never used a galvanometer in a car, so I do not know what is going to happen.

I think, however, I have the advantage of Prof. Goss, in the fact that I certainly have made over twenty locomotive road tests, and when it comes to the question of installing our apparatus on the locomotive or making our connections back to our car, the latter is so much superior and so much more easily accomplished that I would not think of making locomotive road tests if it were possible to have a car, without the facilities which a car affords. I shall take occasion very soon to invite Prof. Goss over, and he must go with us some time and then he will know all that we know about this particular method.

Prof. Goss: There is one more question that is suggested by this discussion. Enough has been said to show that there are two very distinct problems involved by road tests. One really concerns train resistance and the other locomotive performance. Would it not be a great thing to recognize this difference in a more formal way? The purchaser of a locomotive should not be required to test the performance of his engine except as a check on the builder. Wouldn't it be a matter of satisfaction to roads receiving new locomotives to have the assurance of the builder that the locomotive had been in a testing plant, had been tested, and had given results so satisfactory as to preclude the possibility of defects in draft appliances or of misplaced core in cylinder or saddle, or of any other serious thing? Is this, after all, anything more than the builders ought to do for their own information and for the protection of their customers?

President Hetzler: I am certain that we all appreciate Prof.

Breckenridge's paper and remarks, and hope that he will come back to us next year with further information in regard to his car.

I believe this closes the discussion on the paper of the day. We will now hear the reports of the Secretary and Treasurer, so as to give the members of the Club an idea of the standing of the Club at the present time. I will ask the Secretary to read his report.

The Secretary then read the report as shown in Appendix A of these proceedings.

THE PRESIDENT: Gentlemen, you have heard the Secretary's report, what is your pleasure?

It was moved by Mr. Sargent, and seconded, that the report be accepted. (Carried.)

MR. MANCHESTER: Mr. President, the Secretary has given us a very able report, and brings out very clearly the condition of the Club, our financial condition and the general business that has been done during the past year. While financially we stand well, yet you will observe that there has been an increase in our expense and a decrease in our income, and should this condition continue for a long time it will, in time, deplete the treasury.

It has seemed proper to the Board of Directors, or to the Executive Committee, to furnish the members with bound volumes of the proceedings, in lieu of certain other expenditures that have occurred in years past, and in talking with the various members it seems to be their opinion that this is a very satisfactory way of spending the money.

Many of the members feel that they are getting something in the exchange of proceedings with other clubs. This also, under the conditions as shown by the Secretary, is putting the Club to a disadvantage financially, we being so much larger a purchaser of proceedings from the other clubs as compared with what they buy from us.

Now, there is one way in which we can help this matter decidedly and still keep on, if it is the will of the Club that these expenditures continue, and that is, for everybody to hustle for additional members, get more good material into the Club, get in a diversity of material, and not confine it to the mechanical and supply men, but go out in all the different lines of railroading and get good live men to come here and give us papers, help discuss papers with us and make the Western Railway Club of more importance than it has ever been before. And I should have been pleased if the Secretary had added

among his recommendations that everybody make themselves a committee of one to hustle for good members.

MR. J. F. DEEMS (C., B. & Q. R. R.): I want to say just a word with reference to one matter mentioned in the report, and that is the Club Library. I think many of the members do not really appreciate the value of the library, and I do not think they avail themselves of it as often as they might. I recently had occasion to use the library to a considerable extent, and will say that the results were very gratifying indeed. The file that is kept there of all the various railroad papers is very complete, and it is in such a shape that almost any information pertaining to railroad matters, on which you may want information, can be furnished by the librarian on very short notice, and it seems to me we might do more to patronize and assist the library than we do.

MR. WICKHORST: Mr. Manchester makes the suggestion that every one appoint himself a committee of one, to get new members. There was a practice some time ago by which our Secretary sent out with each copy of the proceedings an application blank. I think it would be a good idea if the Secretary would take up that practice again, because I know when that practice was in force I got some new members in, just because of the reminder that we got each month in that way.

THE SECRETARY: I did not know that was the practice before I became Secretary. Under our present arrangement with the post-office we can not send them out with the proceedings, because nothing is allowed in the package containing the proceedings but the proceedings, but with the notice of the meetings I will see that every member gets a copy of the application blank.

PRESIDENT HETZLER: Any remarks? If not, all in favor of the motion will please say aye. (Carried.)

PRESIDENT HETZLER: The Secretary, in his report, recommends that proper record of respect for the dead be made in our Club proceedings. A motion is in order.

MR. PECK: I move that that be left to the Secretary.

Motion was carried.

PRESIDENT HETZLER: He also suggests that notice be issued if the membership dues are not paid within six months after the bills are sent out after the beginning of the fiscal year, that the sending of pro-

ceedings be discontinued until such time as the dues are paid of members already in arrears six months. I think some action is necessary.

On motion of Mr. Peck, the motion was referred to the new board of directors.

President Hetzler: Next report is the report of our Treasurer.

Mr. Peck then read the following report: See Appendix B.

On motion, the report of the Treasurer was accepted.

President Hetzler: I will ask Mr. Sargent, as chairman of the trustees of the David L. Barnes Library, to make his report.

Mr. Sargent then read the following report: See Appendix C.

On motion, the report of the Library Committee was accepted.

Mr. Manchester: In what shape does that leave the recommendation of the committee on certain action?

President Hetzler: A motion is in order. In this report the committee says, "We would suggest that such action be taken by the Club as will express its appreciation of the work done by Mrs. Woods, and that your action may appear on the Club records."

Mr. Delano: I move that the grateful thanks of the Club be extended to Mrs. H. de K. Woods for her labors of four years' duration in caring for the library, and that the Secretary of the Club be instructed to write to her, expressing the sense of this meeting and the vote of the Club in this matter.

Motion was carried.

President Hetzler: Further, "Your trustees have expressed to the *Railroad Gazette* sincere appreciation of the Club for their generous assistance, and would suggest that the Club take such action as will properly recognize the courtesy received, and that this action may also appear on the Club records." A motion is in order in that regard.

Mr. Manchester: Mr. President, I move that it be the sense of this meeting of the Club that they appreciate the kindness of the *Railroad Gazette* in their efforts to assist in building up and maintaining our library, and that the hearty thanks of the Club be extended to them for the same. (Carried.)

In accordance with the resolutions above adopted, the Secretary has written to Mrs. Woods and the Railroad Gazette, expressing the appreciation of the Club for their services, and acknowledgment of same has been made.

Mr. Manchester: Is not there a further recommendation about cataloguing?

On motion of Mr. Peck, the matter was referred to the new Board of Directors.

President Hetzler: I think this clears up our business for today. The next in order is the election of officers for the ensuing year. The first officer to be elected is President. I will ask to serve as tellers, Mr. Sargent, Mr. Clark and Mr. Deems.

Mr. Deems declining to serve, Mr. Peck was named in his place.

The result of the informal ballot was as follows:

Total number of votes cast for President, 34.

Mr. A. E. Manchester, 21.

Prof. W. F. M. Goss, 8.

Mr. G. W. Cushing, 2.

Mr. G. W. Rhodes, 1.

Mr. J. F. Deems, 2.

Mr. Manchester: Is electioneering in order?

Cries of, "No! No!"

Mr. Delano: I do not think any of the candidates ought to be allowed to say anything. I make the motion that the Secretary of this Club cast the ballot of this Club for Mr. Manchester for President.

Carried, and Mr. Manchester declared duly elected.

The informal ballot for Vice President resulted as follows:

Prof. W. F. M. Goss, 26.

Mr. W. H. Marshall, 2.

Mr. J. F. Deems, 3.

Mr. R. D. Smith, 1.

Mr. P. H. Peck, 1.

A motion that the Secretary be instructed to cast the ballot of the Club for Prof. Goss as First Vice President was carried.

The informal ballot for Second Vice President resulted as follows:

Total number of votes cast, 30.

Mr. B. Haskell, 2.

Mr. R. D. Smith, 5.

Mr. F. A. Delano, 1.

Mr. F. H. Clark, 3.

Mr. J. F. Deems, 8.

Mr. W. H. Marshall, 6.

Mr. G. W. Cushing, 3.

Prof. L. P. Breckenridge, 2. (No choice.)

PRESIDENT HETZLER: The three highest are Messrs. Deems, who has 8; Marshall, 6; Smith, 5. Another ballot is necessary.

The second ballot for Second Vice President resulted as follows: J. F. Deems, 15; W. H. Marshall, 9; R. D. Smith, 7. (No choice.)

On the third ballot Mr. Deems received 15 votes, and Mr. Marshall 8, whereupon Mr. Deems was declared elected.

An informal ballot was then taken for Treasurer. Out of a total of 29 votes, Mr. Peck received 27, and on motion of Mr. Delano the vote was made unanimous.

PRESIDENT HETZLER: The next in order is the informal ballot for two Directors. I think it would be well to vote for both directors at the same time.

The result of informal ballot for directors was:

Total number of votes cast, 29.

Mr. R. D. Smith, 16.

Mr. Geo. James, 6.

Mr. W. H. Marshall, 6.

Mr. G. R. Henderson, 9.

Mr. B. Haskell, 9.

The rest scattering.

On motion of Mr. Peck, the vote for Mr. R. D. Smith as director was made unanimous.

A ballot was then taken for the two next highest, being Messrs. G. R. Henderson and B. Haskell, the result being: Mr. Henderson 18, Mr. Haskell 5, out of a total of 25 votes.

On motion the Secretary was instructed to cast the ballot of the Club for Mr. Henderson.

PRESIDENT HETZLER: The next in order is the informal ballot for the three Library Trustees.

The informal ballot resulted as follows:

Mr. Sargent, 25.

Mr. Delano, 23.

Mr. Forsyth, 21.

(Rest scattering.)

On motion, the Secretary was instructed to cast the ballot of the Club for Messrs. Sargent, Delano and Forsyth.

PRESIDENT HETZLER: The following officers have been elected: President, Mr. A. E. Manchester; First Vice President, Prof. W. F. M. Goss; Second Vice President, Mr. J. F. Deems; Treasurer, Mr. P. H. Peck; Directors, Messrs. R. D. Smith and G. R. Henderson; and the former Trustees of the Library. I believe there is nothing further, and a motion to adjourn is in order.

Adjourned.

In Memoriam

L. C. Burgess
DIED OCTOBER 1, 1898

A. H. Polhamus
DIED MARCH 11, 1899

Frank Bruce
DIED APRIL 14, 1899

Geo. D. Walcott
DIED MAY 12, 1899

F. W. Winne
DIED MAY 29, 1899

W. H. Harrison
DIED SEPTEMBER 23, 1899

E. N. Lewis
DIED FEBRUARY 16, 1900

APPENDIX A.

REPORT OF SECRETARY.

To the President and Board of Directors:

Below is given a short review of the condition of the Club as to membershlp, finances, etc., and also a resume of the work done during the year :

MEMBERSHIP.

Number of members at date of last annual report, May 14, 1899			906
Resigned		33	
Suspended	Non-Payment of Dues	55	
	Mail returned, etc	13	
Deaths		7—	108
			798
New members			102
Total membership			900

The names of the following members have been taken from the membership list by reason of death, some of which occurred prior to the fiscal year just closed: W. H. Harrison, Frank Bruce, Geo D. Walcott, L. C. Burgess, F. W. Winne, A. H. Polhamus and E. N. Lewis. I would recommend that appropriate record of respect for the dead be made in our Club proceedings.

It will be noticed that a large number of members were suspended during the year for the non-payment of dues. These are members who owed the Club for two years. As the cost of furnishing the proceedings to this large number is quite an item of expense, I would suggest that notice be issued that if the membership dues are not paid within six months after the bills are sent out, at the beginning of the fiscal year, that the sending of the proceedings be discontinued until such time as the dues are paid ; that in the case of members already six months in arrears for dues the proceedings be discontinued at once.

It may be interesting to know the personnel of our membership, and to this end a statement is given below, detailing this information :

Presidents of Railroads	4
Vice-Presidents	2
General Managers	9
General Superintendents and Assistant General Superintendents	20
Superintendents of Transportation	1
Division Superintendents and Assistants	27
Superintendents Freight Terminals	1
Trainmasters	10
Train Despatchers	3
Brakemen	1
Locomotive Engineers	36
Locomotive Firemen	4
Superintendents M.P. and A.S.M.P.	54
Master Car Builders	22
Master Mechanics and Assistants	95
General Foremen, cars and locomotives	33
Foremen Shops, cars and locomotives	41
Roundhouse Foremen	14
Road Foremen of Engines / Traveling Engineers	18
Mechanical Engineers	14
Chief Draughtsmen and Assistants	22
Engineers of Tests and Assistants	11
Foremen Car Repairs	7
General and Joint Car Inspectors,	3
Master Car Painters	2

Inspectors, locomotive and car departments	10
Air-Brake Instructors	7
Clerks	6
Stationary Engineers	3
Electricians	3
Machinists and Apprentices	21
Consulting Engineers	2
Chief Engineers and Assistants	12
Superintendents B. & B.	1
Roadmasters	4
Engineers M. of W.	4
Signaling Engineers	3
Purchasing Agents	11
General Storekeepers and Assistants	5
General Auditors and Assistants	2
Freight Agents	3
Representatives Private Car Lines	11
" Car Manufacturing Co's.	6
" Locomotive Mfg. Co's.	14
" Railway Papers	13
" Universities	15
" Railway Associations	3
Miscellaneous Railroad Employes	30
Attorneys	2
Supply Men	255
	900

FINANCIAL.

Balance on hand May 16, 1899	$ 1,875.19	
Receipts from all sources	4,796.48	
Total balance		$6,671.67
Expenses—		
Library—Salary Librarian, April, 1899, to May, 1900, inc.	$ 260.00	
Rent Library room	130.00	
Binding and incidentals	58.21	
Purchase of other Club proceedings	866.91	
Salary Secretary, May, 1899, to May, 1900, inclusive	300.00	
Cost of advertisements	543.30	
Postage	426.09	
Reporting proceedings	217.00	
Printing proceedings, advance papers, notices, etc, including binding last year's proceedings	2,105.63	
Office expenses	153.05	
Total expenses		5,060.19
Balance on hand in Treasury May 15, 1900		$1,611.48

Bills payable amounting to $404.83, being the expenses for the club month just closed, will be paid at once, which will leave an unappropriated balance of $1,206.65.

Bills receivable are as follows:

From advertising	$ 485.50
" Dues, $6.00	6.00
" Dues, 4.00	192.00
" Dues, 2.00	152.00
" Sale of proceedings	35.42
Total	$870.92

Of the bills receivable, the items for advertisements and sale of proceedings

will be collected. Of the amount of dues from members, $350.00, probably one-half or more will have to be written off on the wrong side of the ledger, which is another silent argument in favor of some such action as is recommended in another part of this report.

Assuming that $100.00 of the unpaid dues will be collected, this, together with the advertising, $485.50, the sale of proceedings, $35.42, total $620.92, and the unappropriated balance, $1,206.65, would leave the total available balance $1,827.57.

Papers Presented and Discussed.

The papers presented during the year have been of a high character, the discussions full and interesting and of great credit to the Club. They have been well received by the railway public, and have been freely copied and favorably commented upon by the railway papers.

It might be of interest, in passing, to call attention to the sources of the papers presented. The locomotive and car departments have furnished four papers; the purchasing department two papers; a locomotive engineer one paper; a machinist one paper; a chemist one paper; the legal fraternity two papers; the representatives of universities two papers, and the Health Department of the City of Chicago two papers.

The papers referred to, you have received, so that it is not necessary to enumerate them except as a matter of record. They are as follows:

Locomotive Front Ends............................J. Snowden Bell.
The Smoke Nuisance and the Abatement Thereof......Arthur R. Reynolds, M.D.
Obstacles Preventing the Enforcement of City Ordinances Prohibiting Smoke.......................Jno. C. Schubert.
Piece Work in a Railroad Shop.......................R. T. Shea.
Pooling of Locomotives...............................M. E. Wells.
Patents: What They Are Not?.......................Paul Synnestvedt.
Ton Mile Statistics. ....C. H. Quereau.
What Does it Cost to Run Trains at High Speed? .....F. A. Delano.
Purchasing Under Specifications.....................Ira C. Hubbell.
Bending Test of M. C. B. Arch Bar Truck .. ..C. V. Kerr.
Improved Methods and Facilities for Handling Materials From, Through and Between Various Shops and Store Houses; and Accounting for Same......John M. Taylor.
Locomotive Road Tests—How They should be Made...Prof. L. P. Breckenridge.

The following topical subjects were discussed:

Closing Slot in M. C. B. Knuckle.
Boiler Feed Waters.
Revision of the Rules for Loading Long Materials.

Special committees appointed have reported:

The Smoke Nuisance.
Revision of the Rules of Interchange.

General.

The issuance of a bound volume of the Club proceedings to each member not in arrears for dues, as recommended by the Board of Directors and approved by

the Club last year, has been deemed a wise expenditure of the Club funds, and with your authorization the necessary additional copies of the monthly proceedings have been printed and held in store to continue the practice this year.

Regarding the matter of exchange of proceedings with other clubs, a statement of the number we are purchasing from and selling to the different clubs with which arrangements were made to furnish them at cost, is as follows :

	Purchasing from. (Monthly.)	*Selling to.* (Monthly.)
New England Railway Club	200 copies.	168 copies.
New York Railway Club	202 "	6 "
Central Railway Club	180 "	57 "
Southern & South-Western Railway Club	159 "	45 "
Northwest Railway Club	186 "	22 "

We have paid out to the different clubs during the year, for their proceedings, $866.91, and have received from the sale of our proceedings to clubs, in exchange, $430.39, resulting in a balance against us of $436.52.

During the month of April, 1900, arrangements were finally completed with the Post Office Department whereby the proceedings of the Club have been entered as second-class matter. Under this arrangement it is expected that the item of expense for postage will be materially reduced.

In closing this report, I would call the attention of the members to the Library. The report of the trustees, as to its condition, will be read to you today.

I fully believe the members do not appreciate its value, and would suggest a more general use of its files, either by personal visits or by correspondence with the Librarian. Yours truly,

Jos. W. Taylor, Secretary.

APPENDIX B.

Income.

1899—		
August 14	F. M. Whyte	$ 765.27
September 19	F. M. Whyte	719.75
September 22	J. W. Taylor	205.65
October 17	J. W. Taylor	152.00
October 20	J. W. Taylor	395.25
November 13	J. W. Taylor	361.70
November 20	J. W. Taylor	96.92
November 21	J. W. Taylor	259.50
December 18	J. W. Taylor	251.45
1900—		
January 3	J. W. Taylor	350.69
January 15	J. W. Taylor	86.64
January 31	J. W. Taylor	311.26
February 12	J. W. Taylor	217.42
February 26	J. W. Taylor	253 12
March	J. W. Taylor	178.06
April 3	J. W. Taylor	332.04
April 16	J. W. Taylor	62.14
May 14	J. W. Taylor	186.74
		$5,185.60

EXPENDITURE.

1899—	
September 21	$ 124.15
October 18	435.37
November 23	428.52
December 19	639.14
1900—	
January 16	364.60
February 20	517.79
March 23	517.87
April 17	546.68
	$3.574.12

Income	$5.185.60
Expenditure	3,574.12
Balance in hand	1,611.48

PETER H. PECK, Treasurer.

APPENDIX C.

CHICAGO, May 11, 1900.

To the Officers and Members of the Western Railway Club :

GENTLEMEN:—Your Trustees of the David L. Barnes' Library beg to submit the Fourth Annual Report of the condition of the Library, which has been opened for general use since January 1, 1897, or three and a half years.

The Library is located at 1750 Monadnock Building, and until the first of the present month has been under the charge of Mrs. H. deK. Woods, who was appointed Librarian when the Club took hold of the Library in January, 1897. Through the courtesy of the *Railroad Gazette* an arrangement was made at that time whereby a portion of the rental of the Library room was contributed by it, leaving only a charge of $10.00 per month to be paid by the Club. This arrangement ceased on May 1, when the *Railroad Gazette* signified its willingness to contribute the full rental of the Library quarters, which was gratefully accepted by the Library Trustees. This means a reduction in the operating expenses of the Library of $120 per year, or nearly 30 per cent.

In the first catalogue of the Library, dated September 1, 1897, there appeared 824 volumes of books, pamphlets and engineering files. Up to the present time the Library has increased over 50 per cent, and stands today the most complete epitome of railway progress in this section of the country, as regards matters in which the Western Railway Club members are most deeply interested. We have complete files of the principal railway and engineering journals for the past twelve or fifteen years, and also complete files of the reports of the Master Car Builders' and Master Mechanics' associations, and the various railway club proceedings. A large number of books, pamphlets, etc., pertaining to railway and engineering work has been presented to the Library, so that the present quarters of the Library are well filled up, and the question of more room must soon be considered. In this connection, we are pleased to state that the *Railroad Gazette*, in whose suite of offices the Club Library is located, has kindly consented to the re-

moval of the Library from its present room to the one adjoining, which is larger and permits of a better arrangement and possible expansion of the Library. Since the first of the year, twenty-eight volumes of the current railway and engineering papers and club proceedings have been bound up, completing the files to January, 1900, and increasing the Library to close unto 1,500 volumes of books, pamphlets and engineering files.

During the past year about 300 persons have visited the Library, an increase of about 30 per cent over last year.

The Library has been well cared for, and is in the best condition for active use, the arrangement being such that ready access can be obtained to all data for references ; and much assistance has been rendered by the Librarian, Mrs. H. deK. Woods, during her term of office, to the members of the Club and others who have made use of the facilities offered by the Library during its existence.

The present condition of the Library—its care, arrangement and increase in capacity—have been due, in a very large measure, to the energy and ability of Mrs. H. deK. Woods, who has been unceasing in her efforts to develop the Library, and, next to Mrs. Woods, to the generous assistance of the *Railroad Gazette* in providing quarters, in contributing books and other matter for the Library files. On May 1, Mrs. H. deK. Woods resigned as Librarian to accept a position in the Congressional Library at Washington, and in accepting her resignation your Trustees testified their appreciation of her valuable services in behalf of the Library, and in presenting this report to the Club we beg to suggest that such action be taken by the Club as will express its appreciation of the work done by Mrs. Woods, and that your action may appear on the Club records.

Further, your Trustees have expressed to the *Railroad Gazette* the sincere appreciation of the Club for their generous assistance, and we suggest that the Club take such action as will appropriately recognize the courtesies received, and this action may also appear on the Club records.

Your Board of Library Trustees has selected Mr. J. C. Whitridge as Librarian. Mr. Whitridge is well fitted to care for the Library He was an assistant to Mr. David L. Barnes when the Library was being built up, and is thoroughly familiar with all the matter contained therein ; in addition, he is a trained mechanical engineer of large acquaintance among the Club members, and in his charge we expect the Library to increase in value and usefulness.

In conclusion, we wish to impress upon the members of the Western Railway Club the importance of visiting and using their Library. You have at your command the most complete records of railway progress kept up to date, and under proper encouragement the Library can be made a very strong supplement to the valuable work done by the Western Railway Club, which is the recognized leading institution of the kind in this country. A list of all accessions to the Library since the publication of the catalogue in 1897 is herewith attached, and it is recommended that a new catalogue be published, showing the material in the Library up to the present time. Respectfully submitted,

F. W. Sargent,
Wm. Forsyth,
F. A. Delano,
Trustees.

ADDITIONS TO LIBRARY

JANUARY TO MAY, 1900.

Mr. J. B. Dickson, Secretary: Proceedings Seventeenth Annual Convention Roadmasters' Association, September, 1899.

From the Secretary: Transactions American Society Mechanical Engineers, Vol. XX, 1899.

Mr. Walter H. Smith, Librarian: Bulletin University of Wisconsin Engineering series, Vol. 1, Nos. 1–10, complete; Vol. 2, Nos. 1–4, inclusive.

Engineers Society Western Pennsylvania: Proceedings, Vol. XV, Nos. 7–10, inclusive. September-December, 1899.

The Railway Age, by Mr. H. M. Wilson, Manager: Biographical Directory of Railway Officials of America, 1896.

From the Secretary: Copy Constitution and List of Members, Engineers Club, New York, 1899.

S. F. Patterson, Secretary: Proceedings Ninth Annual Convention, Association Railway Superintendents of Bridges and Buildings, October, 1899.

Secretary of State of Massachusetts: Report of Special Committee on Relations between Cities and Towns and Street Railways, 1898.

Mr. C. B. Conger: Air Brake Catechism, editions of August, 1899, and January, 1900, by C. B. Conger.

Mr. E. W. Burdett: Argument of E. W. Burdett, Esq., before the Massachusetts Special Committee of Street Railroad and Municipal Corporations, Dec. 3, 1897.

Edward A. Moseley, Secretary: Preliminary Report on Income Account of Railways in United States, June 30, 1899.

R. W. Pope, Secretary: Transactions American Institution of Electrical Engineers, Vol. XV, 1898. Cloth, pp. 812.

U. S. Wind Engine & Pump Co.: Copy Railway Water Supply Catalogue, 1900. (Red morocco; illustrated.)

Baldwin Locomotive Works: Record of Recent Construction, No. 18, and Circulars Nos. 5 and 12–14, inclusive.

Republic Iron & Steel Co.: Copy 1900 Catalogue.

Brooks Locomotive Works: Illustrated Catalogue, Simple and Compound Locomotives, 1899.

Mr J. N. Reynolds: "The Materials of Construction," Part II—Iron and Steel; cloth—by R. H. Thurson, 1883 edition.

Seventeenth Annual Report of the Ohio Society of Engineers and Surveyors; February, 1896.

Proceedings Annual Meeting, Association of Railway Telegraph Superintendents, June, 1898.

Constitution and List of Charter Members American Railway Engineering and Maintenance of Way Association, December, 1899.

Mr. E. E. R. Tratman: Report of International American Conference on an Intercontinental Railway Line; Government Printing Office, 1890.

Annual Report Department Railways and Canals, Dominion of Canada, 1897.

Annual Report Railway Commissioners, New South Wales, June, 1898.
Report General Manager of Railways, Cape of Good Hope Railway, for 1897.
Returns of Railway Accidents to British Board of Trade, January-March, 1897.
Railway Returns—England, Wales and Scotland--1896.
Return on Continuous Brakes—Railways of Great Britain—1897.
Report on Railways in India, 1897-1898, by A. Brereton. Part II.
English Rules for Working the Westinghouse Brake ; illustrated.
The Vacuum Automatic Brake.
Also, thirty miscellaneous pamphlets and copies Railroad Club Proceedings.

The David L. Barnes Library

Special Notice

The David L. Barnes Library of this Club, at 1750 the Monadnock, Chicago, is open for the use of members and their friends, and we hope it will be used freely It is open on week days from 9 a. m. to 5:30 p. m., except on Saturday, until 3 p. m. Books must not be removed from the Library, but the Librarian will assist visitors in finding information and will promptly reply to letters from out-of-town members desiring information from the Library. Donations of books and technical publications will be gratefully received.

TRUSTEES TO THE LIBRARY.

List of duplicate copies of the Proceedings of the Western Railway Club which are in the David L. Barnes Library and are for sale or exchange :

1888—Sept. and Oct. (bound in one).
1889—Oct., Dec.
1890—Feb., Sept., Oct., Nov., Dec.
1891—Jan., Mar., Apr., May, Oct., Nov.
1892—Jan., Feb., Apr., May, Sept., Nov., Dec.
1893—Two complete volumes; also single copies of Jan., Feb., Mar., May, Sept., Oct., Nov., Dec.
1894—Jan., Mar., Apr., May, Oct., and Index of subjects discussed by the Club.
1895—Apr., Sept., Oct., Nov., Dec.
1896—One complete volume; also single copies of Mar., May, Sept., Nov., Dec.
1897—Jan., Apr., May, Sept., Nov., Dec.
1898—Jan., Feb., Mar., Apr., May, Sept., Oct., Nov., Dec.
1899—May.

Correspondence relating to the Library donations of books, periodicals, etc. for the files, or duplicates sent for exchange, should be addressed to J. C. Whitridge, Librarian, 1750 Monadnock, Chicago.

List of Back Numbers of the Western Railway Club Proceedings on Hand.

1889,	September	5	copies
1890,	September	10	"
	October	25	"
1891,	January	24	"
	February	11	"
	March	12	"
	April	20	"
	May	26	"
1892,	April	32	"
	September	15	"
	November	17	"
	December	10	"
1893,	January	29	"
	February	3	"
	March	10	"
	April	7	"
	May	15	"
	September	5	"
	October	12	"
	November	32	"
	December	22	"
1894,	January	6	"
	February	3	"
	April	1	"
	May	4	"
	October	3	"
1895,	February	1	"
	September	26	"
	October	36	"

1896,	January	26	copies
	February	1	"
	March	98	"
	April	1	"
	May	1	"
	September	12	"
	October	4	"
	November	12	"
	December	12	"
1897,	January	1	"
	February	1	"
	March	1	"
	April	3	"
	September	1	"
	October	1	"
	November	39	"
	December	188	"
1898,	January	133	"
	February	134	"
	March	55	"
	April	8	"
	May	181	"
	September	165	"
	October	68	"
	November	171	"
	December	71	"
1899,	January	67	"
	February	128	"
	March	47	"
	April	32	"
	May	12	"
	Total	2,096	

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OFFICIAL PROCEEDINGS

Western Railway Club

Organized April, 1884 — Incorporated March, 1897

Vol. 12 — May, 1900 — No. 9

Discussion:

Paper:

LOCOMOTIVE ROAD TESTS. HOW SHOULD THEY BE MADE

Prof. L. P. Breckenridge

Election of Officers

Next Meeting, September 18, 1900

W. F. Hall Printing Company, Chicago

Classified Index of Advertisements

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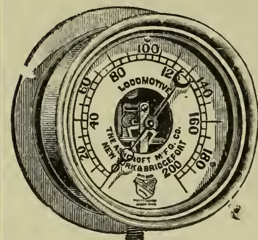

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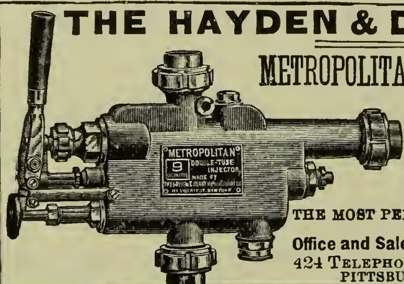

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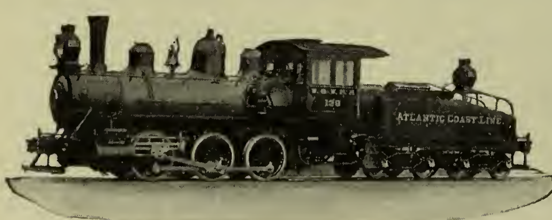

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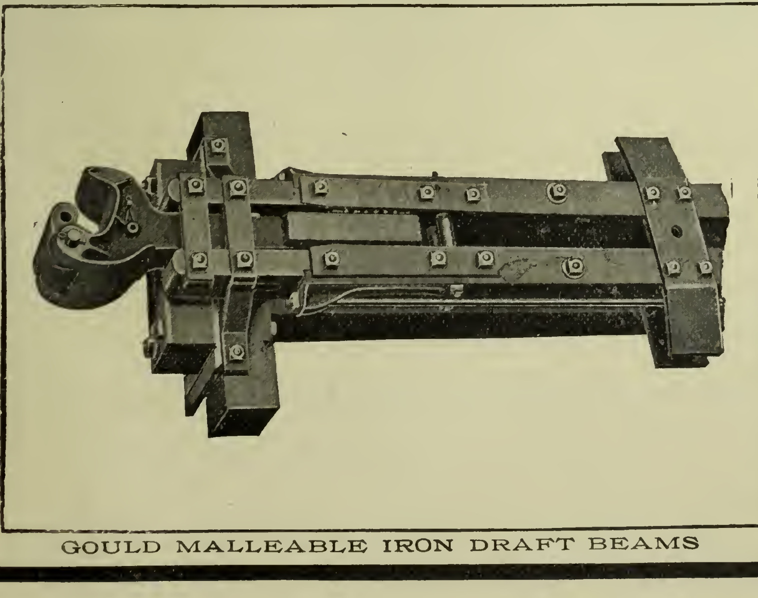

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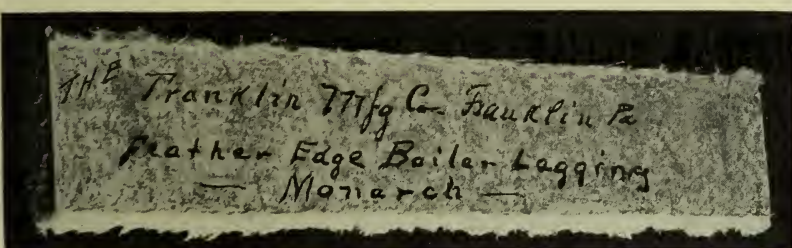

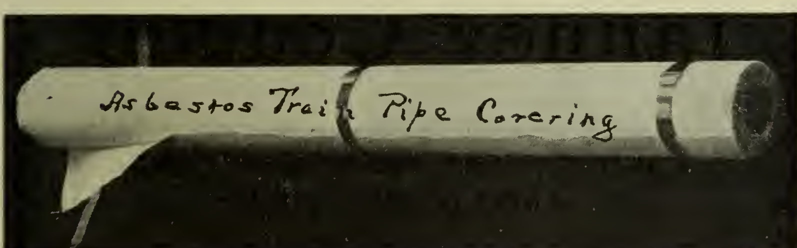

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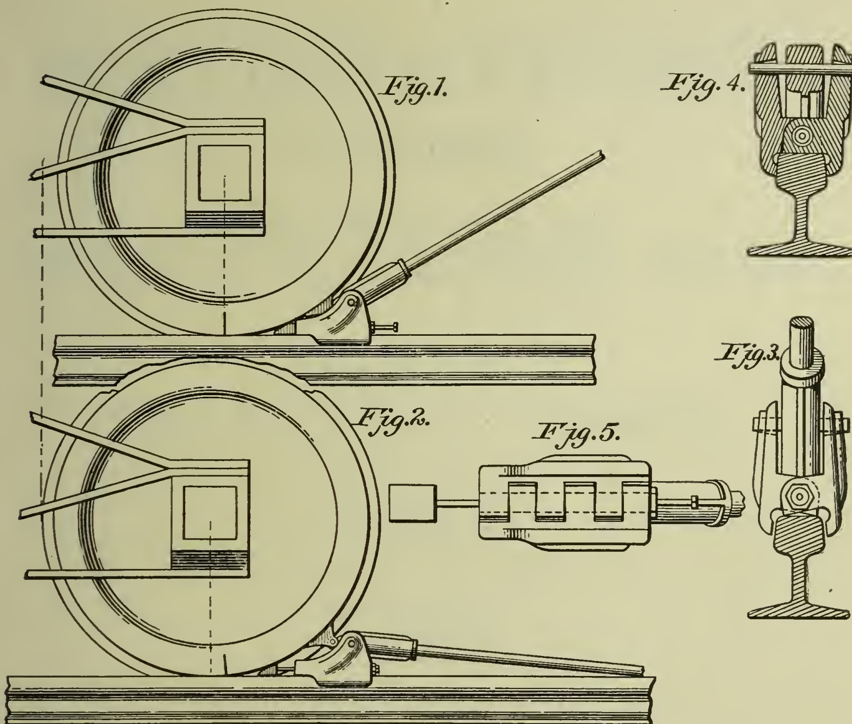
Fig. 1.
Fig. 4.
Fig. 3.
Fig. 2.
Fig. 5.